This document was too large to scan as a single document. It has been divided into smaller sections.

Section 3 of 4

Document Information			
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Title	FEASIBILITY STUDY FOR THE 200-PW-2 URANIUM RICH PROCESS WASTE GROUP & 200-PW-4 GENERAL PROCESS CONDENSATE WASTE GROUP OU [DRAFT A]		
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APPENDIX D

TABLES FOR THE BASELINE HUMAN-HEALTH RISK ASSESSMENT, SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT, AND GROUNDWATER PROTECTION RISK ASSESSMENT

DA1.0 INTRODUCTION

This appendix contains tables that support the discussion in Section 2.7 of the feasibility study, which summarizes the detailed risk-assessment presentation in the remedial investigation. The tables in this appendix are condensations of those in DOE/RL-2004-25, *Remedial Investigation Report for the 200-PW-2 Uranium-Rich Process Waste Group and 200-PW-4 General Process Condensate Group Operable Units.*

Table D-1. Summary of Nonradiological Contaminants of Potential Concern Identified at Each Representative Waste Site.

Constituent Name	207-A South Retention Basin		216-A-10 Crib		216-A-19 Trench		216-A-36B Crib		216-A-37-1 Crib		216-B-12 Crib		216-S-7 Crib	
	Eco	GWP	Eco	GWP	Eco	GWP	Eco	GWP	Eco	GWP	Eco	GWP	Eco	GWP
2-(2,4,5-Trichlorphenoxy) Propionic	X [a]													
2,4-Dichlorophenoxyacetic Acid	X [a]													
Acetone									X [a]					
Aluminum										X				
Arsenic	X	X				X			X			X		X
Barium									X					
Beta-1,2,3,4,5,6-			X [a]	X										
Bis(2-Ethylhexyl) Phthalate					X [a]				X [a]		X [a]			
Boron			X		X				X		X			
Butylbenzyl Phthalate	X [a]													
Chromium VI													X [a]	
Isophorone								X						
Manganese						X				X				
Methylene chloride				X										
Nitrate and nitrate/nitrite as N [b]		X		X		X		X		X		X		X
Nitrate as N						X		X		X		X		X
Nitrite as N								X						
Oil and Grease				X [a]				X [a]						
Pentachlorophenol				X										
Silver	X						X						X	
Total petroleum hydrocarbon – Kerosene				X [a]										
Tributyl phosphate				X	X [a]	X			X [a]					
Uranium					X	X		X				X		X
Vanadium					X									

Note – Blank cells indicate that constituents were not present in concentrations that exceeded both the background and screening values.
[a] No screening value is available, and either concentration exceeds background or no background is available.
[b] Nitrate/nitrite screened against nitrite risk-based criteria.
Eco = ecological: screened against WAC 173-340-900, "Tables," Table 749-3 "Ecological Indicator Soil Concentration for Protection of Terrestrial Plants and Animals."
GWP = groundwater protection: screened against WAC 173-340-747, "Deriving Soil Concentrations for Ground Water Protection," calculated values.

Table D-2. Summary of Radiological Contaminants of Potential Concern Identified at Each Representative Waste Site.

Constituent Name	207-A South Retention Basin			216-A-10 Crib			216-A-19 Trench			216-A-36B Crib			216-A-37-1 Crib			216-B-12 Crib			216-S-7 Crib		
	Ind	GW	Eco	Ind	GW	Eco	Ind	GW	Eco	Ind	GW	Eco	Ind	GW	Eco	Ind	GW	Eco	Ind	GW	Eco
Cs-137													X						X		
H-3		X											X	X			X		X	X	
I-129					X																
K-40				X		X															
Nb-94			X																		
Ni-63									X												
Np-237						X															
Ra-226	X																				
Sn-126																		X			
Tc-99											X									X	
Th-230			X													X		X			
U-234							X														
U-238							X														

Groundwater protection and industrial direct exposure results modeled with RESRAD (residual radioactivity) computer model (ANL 2002, *RESRAD for Windows*, Version 6.21, based on laboratory sample results.

Ecological data were screened against biota concentration guidelines in DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*.

Blank cells indicate that constituents did not contribute to a modeled dose and/or risk for human health, or were not present in concentrations that exceeded both the background and the screening values for ecological risk.

Eco = ecological.
GW = groundwater protection.
Ind = industrial direct exposure.

Table D-3. Summary of Exposure Assumptions for Industrial Soil Risk-Based Concentrations.

Parameter	Symbol	Units	Industrial Land Use [a, b]
Target risk	TR	unitless	1.0 E-05
Target hazard quotient	THQ	unitless	1
Oral reference dose	RfDo	mg/kg-day	chemical specific
Oral cancer potency factor	CPFo	kg-day/mg	chemical specific
Inhalation reference dose	CPFi	mg/kg-day	chemical specific
Inhalation cancer potency factor	RfDi	kg-day/mg	chemical specific
Unit Conversion factor	UCF	mg/kg	1.0 E+06
Body weight –adult	BWa	kg	70
Carcinogenic averaging time	ATC	years	75
Noncarcinogenic averaging time	ATN	years	20
Exposure frequency	EF	unitless	0.4
Exposure duration	ED	years	20
Incidental soil ingestion rate	SIR	mg/day	50
Inhalation rate – carcinogens	INHc	m^3/day	20
Inhalation rate – noncarcinogens	INHnc	m^3/day	20
Gastrointestinal absorption factor	ABSgi	unitless	1
Inhalation absorption fraction	ABSinh	unitless	1

[a]WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties," (equations 745-1 and 745-2).
[b]WAC 173-340-750(4), Cleanup Standards to Protect Air Quality," "Method C Air Cleanup Levels."

Table D-4. Comparison of Maximum Shallow-Soil Concentrations Above Background to Soil Risk-Based Concentrations. (4 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Maximum Detected Result	Industrial Soil RBC[a]	Does Maximum Concentration Exceed Industrial Soil RBC?
207-A South Retention Basin								
CONV	Nitrate and nitrate/nitrite as N[b]	mg/kg	13	13	100%	20.9	3.50 E+05	No
CONV	Nitrate as N	mg/kg	13	11	85%	21.8	5.60 E+06	No
METAL	Arsenic	mg/kg	13	10	77%	9.98	87.5	No
METAL	Silver	mg/kg	13	2	15%	5.01	17,500	No
PEST/PCB	2-(2,4,5-trichlorophenoxy)propionic acid	µg/kg	13	4	31%	3.3	2.80 E+07	No
PEST/PCB	2,4-dichlorophenoxyacetic acid	µg/kg	13	1	8%	7.1	3.50 E+07	No
SVOC	Butylbenzylphthalate	µg/kg	6	1	17%	110	7.00 E+08	No
SVOC	Diethylphthalate	µg/kg	6	1	17%	320	2.80 E+09	No
216-A-10 Crib								
CONV	Nitrate and nitrate/nitrite as N[b]	mg/kg	1	1	100%	1.0	3.50 E+05	No
CONV	Nitrite as N	mg/kg	1	1	100%	0.40	3.50 E+05	No
METAL	Antimony	mg/kg	1	1	100%	0.48	1,400	No
METAL	Boron	mg/kg	1	1	100%	0.89	7.00 E+05	No
Pest/PCB	Beta-1,2,3,4,5,6-hexachlorocyclohexane (B-BHC)	µg/kg	1	1	100%	7.0	72,917	No

Table D-4. Comparison of Maximum Shallow-Soil Concentrations Above Background to Soil Risk-Based Concentrations. (4 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Maximum Detected Result	Industrial Soil RBC[a]	Does Maximum Concentration Exceed Industrial Soil RBC?
216-A-19 Trench								
CONV	Fluoride	mg/kg	1	1	100%	5.62	2.10 E+05	No
CONV	Nitrate and nitrate/nitrite as N[b]	mg/kg	1	1	100%	544	3.50 E+05	No
CONV	Nitrate as N	mg/kg	1	1	100%	546	5.60 E+06	No
METAL	Arsenic	mg/kg	1	1	100%	7.00	87.5	No
METAL	Boron	mg/kg	1	1	100%	38.9	7.00 E+05	No
METAL	Thallium	mg/kg	1	1	100%	0.07	245	No
METAL	Uranium	mg/kg	1	1	100%	129	1.05 E+04	No
METAL	Vanadium	mg/kg	1	1	100%	96.1	2.45 E+04	No
SVOC	Bis(2-ethylhexyl)phthalate	µg/kg	1	1	100%	660	9.38 E+06	No
SVOC	Tributyl phosphate	µg/kg	1	1	100%	280,000	2.43 E+07	No
TPH	TPH - Diesel	µg/kg	1	1	100%	2.3E+05	2.00 E+06	No
216-A-36B Crib								
CONV	Nitrate and nitrate/nitrite as N[b]	mg/kg	1	1	100%	2.7	3.50 E+05	No
METAL	Silver	mg/kg	1	1	100%	3.12	17.5 E+04	No
SVOC	Diethyl Phthalate	µg/kg	1	1	100%	280	2.80 E+09	No

Table D-4. Comparison of Maximum Shallow-Soil Concentrations Above Background to Soil Risk-Based Concentrations. (4 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Maximum Detected Result	Industrial Soil RBC[a]	Does Maximum Concentration Exceed Industrial Soil RBC?
216-A-37-1 Crib								
CONV	Nitrate and nitrate/nitrite as N[b]	mg/kg	1	1	100%	489	3.50 E+05	No
CONV	Nitrate as N	mg/kg	2	2	100%	385	5.60 E+06	No
CONV	Nitrite as N	mg/kg	2	1	50%	1.66	3.50 E+05	No
METAL	Barium	mg/kg	2	2	100%	165	2.45 E+05	No
METAL	Boron	mg/kg	2	1	50%	0.51	7.00 E+05	No
METAL	Manganese	mg/kg	1	1	100%	547	4.90 E+05	No
METAL	Thallium	mg/kg	1	1	100%	0.88	245	No
SVOC	Bis(2-ethylhexyl) Phthalate	µg/kg	2	1	50%	21	9.38 E+06	No
SVOC	Diethyl Phthalate	µg/kg	2	1	50%	650	2.80 E+09	No
SVOC	Tributyl Phosphate	µg/kg	2	1	50%	45	2.43 E+07	No
VOC	Acetone	µg/kg	2	1	50%	13	3.15 E+09	No
216-B-12 Crib								
CONV	Nitrate and nitrate/nitrite as N[b]	mg/kg	1	1	100%	16.2	3.50 E+05	No
CONV	Nitrate as N	mg/kg	1	1	100%	13	5.60 E+06	No
CONV	Sulfate	mg/kg	1	1	100%	467	--	No Screening Level
METAL	Antimony	mg/kg	1	1	100%	0.38	1,400	No
METAL	Arsenic	mg/kg	1	1	100%	7.30	87.5	No
METAL	Boron	mg/kg	1	1	100%	1.3	7.00 E+05	No
SVOC	Bis(2-ethylhexyl) Phthalate	µg/kg	1	1	100%	18	9.38 E+06	No
SVOC	Di-n-butylphthalate	µg/kg	1	1	100%	77	3.50 E+08	No
TPH	TPH – gasoline range	µg/kg	1	1	100%	110	1.00 E+05	No

Table D-4. Comparison of Maximum Shallow-Soil Concentrations Above Background to Soil Risk-Based Concentrations. (4 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Maximum Detected Result	Industrial Soil RBC[a]	Does Maximum Concentration Exceed Industrial Soil RBC?
216-S-7 Crib								
CONV	Nitrate and nitrate/nitrite as N[b]	mg/kg	1	1	100%	6.0	3.5E+05	No
METAL	Hexavalent Chromium	mg/kg	1	1	100%	0.8	1.05E+04	No
METAL	Mercury	mg/kg	1	1	100%	1.7	1.05E+03	No
METAL	Silver	mg/kg	1	1	100%	3.95	1.75E+04	No
Pest/PCB	4,4'-DDE (Dichlorodiphenyldichloroethylene)	mg/kg	1	1	100%	1.4E-03	3.86E+02	No
Pest/PCB	4-4'-DDT (Dichlorodiphenyltrichloroethane)	mg/kg	1	1	100%	4.2E-04	3.86E+02	No
Pest/PCB	Aldrin	mg/kg	1	1	100%	8.1E-04	7.72E+00	No
SVOA	Diethylphthalate	mg/kg	1	1	100%	6.6E-01	2.80E+06	No
SVOA	Di-n-butylphthalate	mg/kg	1	1	100%	7.9E-01	3.50E+05	No

Constituent statistics and analytical results from Tables 4-9, 4-10, and A-1 of DOE/RL-2004-25, *Remedial Investigation for the 200-PW-2 Uranium-Rich Process Waste Group and 200-PW-4 General Process Condensate Group Operable Unit.* Only constituents exceeding background, or which have no published background value, are presented.

[a] WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties," calculations or Ecology 94-145, *Model Toxics Control Act Cleanup Levels & Risk Calculations (CLARC) Version 3.1*, Table, Method C.

[b] RBC for nitrite used as screening value for nitrate/nitrite.

CONV = conventional parameter.
Pest/PCB = pesticide/polychlorinated biphenyl.
RBC = risk-based concentration.
SVOC = semivolatile organic compound.
TPH = total petroleum hydrocarbon.
VOC = volatile organic compound.

Table D-5. Comparison of Maximum Shallow-Zone Soil Concentrations to Industrial Ambient-Air Risk-Based Concentrations. (3 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Maximum Detected Result	PEF or VF (m^3/kg)	1/PEF or 1/VF (kg/m^3)	Maximum Air Concentration (mg/m^3)[a]	Industrial Ambient Air RBC (mg/m^3)[b]	Does Maximum Air Concentration Exceed Ambient Air Industrial RBC?
207-A South Retention Basin											
PEST/PCB	2-(2,4,5-trichlorophenoxy) propionic acid	µg/kg	6	1	17%	3.30E+00	1.06E+09	9.39E-10	3.10E-09	2.80E+01	No
PEST/PCB	2,4-dichlorophenoxy-acetic acid	µg/kg	6	1	17%	7.10E+00	1.06E+09	9.39E-10	6.67E-09	3.50E+01	No
METAL	Arsenic	µg/kg	13	10	77%	9.98E+03	1.06E+09	9.39E-10	9.37E-06	8.72E-03	No
SVOC	Butylbenzylphthalate	µg/kg	13	1	8%	1.10E+02	1.06E+09	9.39E-10	1.03E-07	7.00E+02	No
SVOC	Diethylphthalate	µg/kg	13	4	31%	3.20E+02	1.06E+09	9.39E-10	3.01E-07	2.80E+03	No
VOC	Chloroform	µg/kg	13	1	8%	5.00E+00	1.22E+04	8.18E-05	4.09E-04	1.63E+00	No
VOC	Methylene chloride	µg/kg	13	1	8%	5.00E+00	1.02E+04	9.77E-05	4.88E-04	7.98E+01	No
216-A-10 Crib											
METAL	Boron	µg/kg	1	1	100%	8.90E+02	1.06E+09	9.39E-10	8.36E-07	2.00E+01	No
PEST	Beta-BHC (B-BHC)	µg/kg	1	1	100%	7.00E+00	1.06E+09	9.39E-10	6.58E-09	7.29E-02	No
216-A-19 Trench											
METAL	Arsenic	µg/kg	1	1	100%	7.00E+03	1.06E+09	9.39E-10	6.58E-06	8.72E-03	No
METAL	Boron	µg/kg	1	1	100%	3.89E+04	1.06E+09	9.39E-10	3.66E-05	2.00E+01	No
SVOC	Bis(2-ethylhexyl)phthalate	µg/kg	1	1	100%	6.60E+02	1.06E+09	9.39E-10	6.20E-07	9.38E+00	No
216-A-36B Crib											
SVOC	Diethylphthalate	µg/kg	1	1	100%	2.80E+02	1.06E+09	9.39E-10	2.63E-07	2.80E+03	No

Table D-5. Comparison of Maximum Shallow-Zone Soil Concentrations to Industrial Ambient-Air Risk-Based Concentrations. (3 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Maximum Detected Result	PEF or VF (m^3/kg)	1/PEF or 1/VF (kg/m^3)	Maximum Air Concentration (mg/m^3)[a]	Industrial Ambient Air RBC (mg/m^3)[b]	Does Maximum Air Concentration Exceed Ambient Air Industrial RBC?
216-A-37-1 Crib											
METAL	Barium	µg/kg	2	2	100%	1.65E+05	1.06E+09	9.39E-10	1.55E-04	2.45E+02	No
METAL	Boron	µg/kg	2	1	50%	5.10E+02	1.06E+09	9.39E-10	4.79E-07	2.00E+01	No
METAL	Manganese	µg/kg	1	1	100%	5.47E+05	1.06E+09	9.39E-10	5.14E-04	4.90E-02	No
SVOC	Bis(2-ethylhexyl)phthalate	µg/kg	2	1	50%	2.10E+01	1.06E+09	9.39E-10	1.97E-08	9.38E+00	No
216-B-12 Crib											
METAL	Arsenic	µg/kg	1	1	100%	7.30E+03	1.06E+09	9.39E-10	6.86E-06	8.72E-03	No
METAL	Boron	µg/kg	1	1	100%	1.30E+03	1.06E+09	9.39E-10	1.22E-06	2.00E+01	No
SVOC	Bis(2-ethylhexyl)phthalate	µg/kg	1	1	100%	1.80E+01	1.06E+09	9.39E-10	1.69E-08	9.38E+00	No
SVOC	Di-n-butylphthalate	µg/kg	1	1	100%	7.70E+01	1.06E+09	9.39E-10	7.23E-08	3.50E+02	No
216-S-7 Crib											
METAL	Barium	µg/kg	1	1	100%	7.14E+04	1.06E+09	9.39E-10	6.71E-05	3.50E-01	No
METAL	Chromium (Total)	µg/kg	1	1	100%	1.20E+04	1.06E+09	9.39E-10	1.13E-05	3.13E-03	No
METAL	Hexavalent Chromium	µg/kg	1	1	100%	8.00E+02	1.06E+09	9.39E-10	7.51E-07	4.46E-04	No
PEST/PCB	Aldrin	µg/kg	1	1	100%	8.1E-01	1.06E+09	9.39E-10	7.60E-10	7.65E-03	No
PEST/PCB	4,4'-DDE (Dichlorodiphenyl-dichloroethylene)	µg/kg	1	1	100%	1.40E+00	1.06E+09	9.39E-10	1.32E-09	3.86E-01	No

Table D-5. Comparison of Maximum Shallow-Zone Soil Concentrations to Industrial Ambient-Air Risk-Based Concentrations. (3 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Maximum Detected Result	PEF or VF (m^3/kg)	1/PEF or 1/VF (kg/m^3)	Maximum Air Concentration (mg/m^3)[a]	Industrial Ambient Air RBC (mg/m^3)[b]	Does Maximum Air Concentration Exceed Ambient Air Industrial RBC?
PEST/PCB	4-4'-DDT (Dichlorodiphenyltrichloroethane)	µg/kg	1	1	100%	4.20E-01	1.06E+09	9.39E-10	3.95E-10	3.87E-01	No
SVOC	Diethylphthalate	µg/kg	1	1	100%	6.60E+02	1.06E+09	9.39E-10	6.20E-07	2.80E+03	No
SVOC	Di-n-butylphthalate	µg/kg	1	1	100%	7.90E+02	1.06E+09	9.39E-10	7.42E-07	3.50E+02	No

Constituent statistics and analytical results from tables in Attachment A of this appendix.

[a] Maximum detected result divided by PEF or VF, as appropriate.

[b] WAC 173-340-750, "Cleanup Standards to Protect Air Quality" and Ecology 94-145, *Model Toxics Control Act Cleanup Levels & Risk Calculations (CLARC) Version 3.1*, calculations.

PEF = particulate emissions factor.
PEST/PCB = pesticide/polychlorinated biphenyl.
RBC = risk-based concentration.
SVOC = semivolatile organic compound.
VF = volatilization factor.
VOC = volatile organic compound.

Table D-6. Parameters Used for RESRAD Analysis for 207-A South Retention Basin, 216-A-10 Crib, 216-A-19 Trench, 216-A-36B Crib, 216-A-37-1 Crib, and 216-B-12 Crib - Industrial Scenario. (6 Pages)

Input Field Description	Parameter	Units	200-PW-2 Operable Unit				200-PW-4 Operable Unit		Rationale and Citation
			216-A-19 Trench	216-B-12 Crib	216-A-10 Crib	216-A-36B Crib	207-A South Retention Basin	216-A-37-1 Crib	
Exposure pathways	--	--	External gamma: active Inhalation: active Plant ingestion: suppressed Meat ingestion: suppressed Milk ingestion: suppressed				Aquatic foods: suppressed Drinking water: suppressed Soil ingestion: active Radon: suppressed		Based on DOE/RL-2000-60, Rev. 1, and WDOH/320-015.
Soil concentrations	Soil concentration	pCi/g	nuclide-specific	nuclide-specific	nuclide-specific	(no COPCs for surface exposure)	nuclide-specific	nuclide-specific	See Table 4-12 for source term data.
	Distribution coefficients	cm^3/g	nuclide-specific	nuclide-specific	nuclide-specific	nuclide-specific	nuclide-specific	nuclide-specific	Distribution coefficients were conservative values applicable to these sites, from Table E.15 of PNNL-11800. See Table 5-2 for nuclide-specific values.
	Radiation dose limit	mrem/yr	15	15	15	15	15	15	This dose limit pertains to calculation of soil guidelines WDOH/320-015.
Contaminated zone (CZ)	Area of CZ	m^2	58	740	1,150	520	150	640	Site-specific dimensions from DOE/RL-2000-60, Rev. 1, and shown in Table 1-2 of this RI.
	Thickness of CZ (Surface Exposure; No Cover)	m	5.6	9.0 (fill modeled as contaminated zone)	9.1 (fill modeled as contaminated zone)	No COPCs in top 4.6 m (15 ft)	4.6	60.9	Assumes homogenous contamination at maximum concentrations from surface to at least 4.6 m (15 ft) bgs across site.
	Thickness of CZ (surface exposure; cover)	m	5.6	0	0	No COPCs in top 4.6 m (15 ft)	3.0	58.5	Based on measured concentrations in RI data.
	Length parallel to aquifer flow	m	7.6	49	84	152	17	213	Site-specific. For screening purposes, this value is the longest axis of the site and is conservative.

Table D-6. Parameters Used for RESRAD Analysis for 207-A South Retention Basin, 216-A-10 Crib, 216-A-19 Trench, 216-A-36B Crib, 216-A-37-1 Crib, and 216-B-12 Crib - Industrial Scenario. (6 Pages)

Input Field Description	Parameter	Units	200-PW-2 Operable Unit				200-PW-4 Operable Unit		Rationale and Citation
			216-A-19 Trench	216-B-12 Crib	216-A-10 Crib	216-A-36B Crib	207-A South Retention Basin	216-A-37-1 Crib	
Cover and contaminated zone (CZ) hydrological data	Cover depth (no cover)	m	0	0 (fill modeled as contaminated zone)	0 (fill modeled as contaminated zone)	No COPCs in top 4.6 m (15 ft)	0	0	Assumes that site is contaminated at maximum concentration from surface to at least 4.6 m (15 ft) bgs.
	Cover depth (cover)	m	4.3	0 (fill modeled as contaminated zone)	0 (fill modeled as contaminated zone)	No COPCs in top 4.6 m (15 ft)	0.33	2.4	Based on measured thickness of fill in borehole logs and depth of waste site from DOE/RL-2000-60, Rev. 1, and shown in Table 1-2 of this RI.
	Cover material density	g/cm³	1.73	1.49	1.73	1.49	1.73	1.73	Site-specific values based on RI results.
	Cover erosion rate	m/yr	0.001	0.001	0.001	0.001	0.001	0.001	RESRAD default.
	Density of CZ	g/cm³	1.73	1.49	1.73	1.49	1.73	1.71	Site-specific values based on RI results.
	CZ erosion rate	m/yr	0.001	0.001	0.001	0.001	0.001	0.001	RESRAD default.
	CZ total porosity	unitless	0.346	0.438	0.346	0.438	0.346	0.354	WHC-EP-0883; assumed to be equal to mean effective porosity for 200 Area soils.
	CZ field capacity	unitless	0.029	0.062	0.029	0.062	0.029	0.038	Based on residual water content; consistent with RI moisture content data.
	CZ Hydraulic conductivity	m/yr	1892	315	1,892	315	1,892	2,030.7	WHC-EP-0883, mean values for 200 Area soils.
	CZ "b" parameter	unitless	4.05	4.38	4.05	4.38	4.05	4.14	Derived from RESRAD Table E.2.
	Humidity in air	g/cm³	Not used	8	8	8	8	8	RESRAD default where H-3 is a COC.
	Evapo-transpiration coefficient	unitless	0.91	0.91	0.91	0.91	0.91	0.91	WDOH/320-015.
	Wind speed	m/s	3.4	3.4	3.4	3.4	3.4	3.4	PNNL-13033.

Table D-6. Parameters Used for RESRAD Analysis for 207-A South Retention Basin, 216-A-10 Crib, 216-A-19 Trench, 216-A-36B Crib, 216-A-37-1 Crib, and 216-B-12 Crib - Industrial Scenario. (6 Pages)

Input Field Description	Parameter	Units	200-PW-2 Operable Unit				200-PW-4 Operable Unit		Rationale and Citation
			216-A-19 Trench	216-B-12 Crib	216-A-10 Crib	216-A-36B Crib	207-A South Retention Basin	216-A-37-1 Crib	
Cover and contaminated zone (CZ) hydrological data (cont.)	Precipitation	m/yr	0.16	0.16	0.16	0.16	0.16	0.16	Based on 16 cm (6.3-in.) average annual rainfall (DOE/RL-92-19).
	Irrigation	m/yr	0	0	0	0	0	0	
	Irrigation mode		--	--	--	--	--	--	
	Runoff coefficient	unitless	0.2	0.2	0.2	0.2	0.2	0.2	RESRAD default.
	Watershed area for nearby stream or pond	m^2	1.0 E+06	1.0 E+06	1.0 E+06	1.0 E+06	1.0 E+06	1.0 E+06	RESRAD default.
	Accuracy for water/soil computations	unitless	0.001	0.001	0.001	0.001	0.001	0.001	RESRAD default.
Saturated zone (SZ) hydrologic data	Density of SZ	g/cm3	1.96	2.45	2.21	1.73	2.21	2.21	Site-specific values based on RI results.
	SZ total porosity	unitless	0.262	0.077	0.166	0.346	0.166	0.166	Assumed equal to effective porosity.
	SZ effective porosity	unitless	0.262	0.077	0.166	0.346	0.166	0.166	WHC-EP-0883; assumed to be equal to mean effective porosity for 200 Area soils.
	SZ field capacity	unitless	0.029	0.01	0.023	0.029	0.023	0.023	Based on residual water content.
	SZ hydraulic conductivity	m/yr	4730	4,415	1,577	1,892	1,577	1,577	WHC-EP-0883; mean value for 200 Area soils, based on conductivity of last vadose stratum intersecting water table.
	SZ hydraulic gradient	unitless	2.4 E-04	9.6 E-05	2.4 E-04	2.4 E-04	2.4 E-04	2.4 E-04	PNNL-14187
	SZ "b" parameter	unitless	4.05	4.05	4.05	4.05	4.05	4.05	Derived from RESRAD Table E.2.
	Water table drop rate	m/yr	0.001	0.001	0.001	0.001	0.001	0.001	RESRAD default.

Table D-6. Parameters Used for RESRAD Analysis for 207-A South Retention Basin, 216-A-10 Crib, 216-A-19 Trench, 216-A-36B Crib, 216-A-37-1 Crib, and 216-B-12 Crib - Industrial Scenario. (6 Pages)

Input Field Description	Parameter	Units	200-PW-2 Operable Unit				200-PW-4 Operable Unit		Rationale and Citation
			216-A-19 Trench	216-B-12 Crib	216-A-10 Crib	216-A-36B Crib	207-A South Retention Basin	216-A-37-1 Crib	
Saturated zone (SZ) hydrologic data (cont.)	Well pump intake depth below water table	m	4.6	4.6	4.6	4.6	4.6	4.6	Typical RCRA well screen length (DOE/RL-2002-42).
	Nondisper-sion or mass-balance transport model	--	MB	MB	ND	MB	MB	MB	Per RESRAD guidance, nondispersion (ND) model used to model potential GW impacts for sites >1000 m². Mass-balance (MB) model, which uses assumption that all contamination leaching from the contaminated zone enters well water, used for sites <1000 m².
	Well pumping rate	m^3/yr	250	250	250	250	250	250	RESRAD default.
Uncontaminated unsaturated zone data	Number of unsaturated strata below CZ	--	4	3	4	5	5	2	Site-specific values based on RI results.
	Thickness of unsaturated strata	m	1.1, 3.6, 45.1, 18.5	2.0, 63.7, 18.6	22.6, 50.9, 10.7, 4.0	3.3, 21.7, 22.4, 25.4, 20.3	5.9, 7.9, 5.4, 37.5, 19.2	22.8, 0.9	Site-specific values based on RI results.
	Soil Density	g/cm3	1.73, 1.49, 1.73, 1.96	2.45, 1.73, 2.45	1.73, 1.49, 1.93, 2.21	1.49, 1.73, 1.49, 1.73, 1.93	1.73, 1.96, 1.49, 1.73, 2.21	1.96, 2.21	Site-specific values based on RI results.
	Total porosity	unitless	0.346, 0.438, 0.346, 0.262	0.077, 0.346, 0.077	0.346, 0.438, 0.272, 0.166	0.438, 0.346, 0.438, 0.346, 0.272	0.346, 0.262, 0.438, 0.346, 0.166	0.262, 0.166	See Cover and CZ inputs.

Table D-6. Parameters Used for RESRAD Analysis for 207-A South Retention Basin, 216-A-10 Crib, 216-A-19 Trench, 216-A-36B Crib, 216-A-37-1 Crib, and 216-B-12 Crib - Industrial Scenario. (6 Pages)

Input Field Description	Parameter	Units	200-PW-2 Operable Unit				200-PW-4 Operable Unit		Rationale and Citation
			216-A-19 Trench	216-B-12 Crib	216-A-10 Crib	216-A-36B Crib	207-A South Retention Basin	216-A-37-1 Crib	
Uncontaminated unsaturated zone data (cont.)	Effective porosity	unitless	0.346, 0.438, 0.346, 0.262	0.077, 0.346, 0.077	0.346, 0.438, 0.272, 0.166	0.438, 0.346, 0.438, 0.346, 0.272	0.346, 0.262, 0.438, 0.346, 0.166	0.262, 0.166	See Cover and CZ inputs.
	Field capacity	unitless	0.029, 0.062, 0.029, 0.03	0.01, 0.029, 0.01	0.029, 0.062, 0.04, 0.023	0.062, 0.029, 0.062, 0.029, 0.040	0.029, 0.030,0.062,0.029, 0.023	0.030, 0.023	Based on residual water content: WHC-EP-0883, mean value for 200 Area Soils.
	Hydraulic conductivity	m/yr	1892, 315, 1892, 4730	4415, 1892, 4415	1892, 315, 946, 1577	315, 1892, 315, 1892, 946	1892, 4730, 315, 1892, 1577	4730, 1577	See Cover and CZ inputs.
	Soil-specific "b" parameter	unitless	4.05, 4.38, 4.05, 4.05	4.05, 4.05, 4.05	4.05, 4.38, 4.05, 4.05	4.38, 4.05, 4.38, 4.05, 4.05	4.05, 4.05, 4.38, 4.05, 4.05	4.05, 4.05	Derived from RESRAD Table E.2.
Occupancy	Inhalation rate	m^3/yr	7,300	7,300	7,300	7,300	7,300	7,300	WDOH/320-015
	Mass loading for inhalation	g/m^3	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	WDOH/320-015
	Exposure duration	yr	25	25	25	25	25	25	WDOH/320-015
	Indoor dust filtration factor	unitless	0.4	0.4	0.4	0.4	0.4	0.4	RESRAD default.
	External gamma shielding factor	unitless	0.8	0.8	0.8	0.8	0.8	0.8	WDOH/320-015.
	Indoor time fraction	unitless	0.137	0.137	0.137	0.137	0.137	0.137	200 Area industrial scenario; on site 2,000 h/yr; indoors 60% (DOE/RL-2002-42).
	Outdoor time fraction	unitless	0.091	0.091	0.091	0.091	0.091	0.091	200 Area industrial scenario; on site 2000 h/yr; outdoors 40% (DOE/RL-2002-42).
	Shape factor	unitless	circular	Site specific; non-circular	Site specific; non-circular	Site specific; non-circular	Circular	Site specific; non-circular	Calculated for grossly non-circular sites using RESRAD program for external irradiation pathway. Shape factor area is used by RESRAD for Area value in CZ field.

Table D-6. Parameters Used for RESRAD Analysis for 207-A South Retention Basin, 216-A-10 Crib, 216-A-19 Trench, 216-A-36B Crib, 216-A-37-1 Crib, and 216-B-12 Crib - Industrial Scenario. (6 Pages)

Input Field Description	Parameter	Units	200-PW-2 Operable Unit				200-PW-4 Operable Unit		Rationale and Citation
			216-A-19 Trench	216-B-12 Crib	216-A-10 Crib	216-A-36B Crib	207-A South Retention Basin	216-A-37-1 Crib	
Ingestion pathway; dietary data	Soil ingestion rate	g/yr	36.5	36.5	36.5	36.5	36.5	36.5	WDOH/320-015.
	Drinking water intake	L/yr	730	730	730	730	730	730	WDOH/320-015. Only used to screen transport of COCs to groundwater.
	Drinking water contaminated fraction		1	1	1	1	1	1	RESRAD default; only used to screen transport of COCs to groundwater.
Ingestion pathway; nondietary data	Depth of soil mixing layer	m	0.15	0.15	0.15	0.15	0.15	0.15	RESRAD default.
	Drinking water fractional use		1	1	1	1	1	1	RESRAD default; only used to screen transport of COCs to groundwater.
Storage Times	Well water storage time	days	1	1	1	1	1	1	RESRAD default; only used to screen transport of COCs to groundwater.

From Table 4-13 of DOE/RL-2004-25, *Remedial Investigation for the 200-PW-2 Uranium-Rich Process Waste Group and 200-PW-4 General Process Condensate Group Operable Unit.*

DOE/RL-92-19, *200 East Groundwater Aggregate Area Management Study.*

DOE/RL-2000-60, *Uranium Rich/General Process Condensate and Process Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan; Includes 200-PW-2 and 200-PW-4 Operable Units*

DOE/RL-2002-42, *Remedial Investigation Report for the 200-TW-1 and 200-TW-2 Operable Units (includes the 200-PW-5 Operable Unit).*

PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site.*

PNNL-13033, *Recharge Data Package for the Immobilized Low-Activity Waste 2001 Performance Assessment.*

PNNL-14187, Hanford Site Groundwater Monitoring for Fiscal Year 2002.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq.

WDOH/320-015, *Hanford Guidance for Radiological Cleanup.*

WHC-EP-0883, *Variability and Scaling of Hydraulic Properties for 200 Area Soils.*

COC = contaminant of concern.
COPC = contaminant of potential concern.
CZ = contaminated zone.
MB = mass balance.
ND = nondispersion.
RCRA = *Resource Conservation and Recovery Act of 1976.*
RESRAD = RESidual RADioactivity (ANL 2002, *RESRAD for Windows*, Version 6.21).
RI = remedial investigation.
SZ = saturated zone.
-- = not applicable.

Table D-7. Parameters Used for RESRAD Analysis, 216-S-7 Crib - Industrial Scenario. (4 Pages)

Input Field Description	Parameter	Units	Industrial Scenario	Groundwater Protection	Rationale and Citation
Exposure pathways (active)	--	--	External gamma Inhalation Soil ingestion	Drinking water	Based on DOE/RL-2000-60, Rev. 1, and WDOH/320-015. For GW protection, drinking water pathway is activated to facilitate evaluation of potential GW impacts.
Soil concentrations	Soil concentration	pCi/g	nuclide-specific	nuclide-specific	See Table RAD4-1 for source term data.
	Distribution coefficients	cm^3/g	nuclide-specific	nuclide-specific	Distribution coefficients for GW protection screening were conservative Source Category H values, from Table E.15 of PNNL-11800.
	Radiation dose limit	mrem/yr	15	15	This dose limit pertains to calculation of soil guidelines WDOH/320-015.
Contaminated zone (CZ)	Area of CZ	m^2	465	465	Site-specific dimensions from Borehole Report (D&D-25034 Rev 0).
	Thickness of CZ (Surface Exposure; No Cover)	m	6.4 (fill modeled as contaminated zone)	25 m (all nuclides except tritium) 65 m (tritium)	Based on measured concentrations in RI data
	Length parallel to aquifer flow	m	30.5	30.5	Site-specific. For screening purposes, this value is the longest axis of the site and is conservative.
Cover and contaminated zone (CZ) hydrological data	Cover depth	m	0 (fill modeled as contaminated zone)	6.4 m	Based on measured thickness of fill in borehole logs.
	Cover material density	g/cm^3	NA	NA	
	Cover erosion rate	m/yr	NA	NA	
	Density of CZ	g/cm^3	2.0	2.0	Site-specific values based on RI results.
	CZ erosion rate	m/yr	0.001	0.001	RESRAD default.
	CZ total porosity	unitless	0.245	0.245	Assumed to be equal to mean effective porosity.

Table D-7. Parameters Used for RESRAD Analysis, 216-S-7 Crib - Industrial Scenario. (4 Pages)

Input Field Description	Parameter	Units	Industrial Scenario	Groundwater Protection	Rationale and Citation
Cover and contaminated zone (CZ) hydrological data (cont.)	CZ field capacity	unitless	0.11	0.11	Based on residual water content; consistent with RI moisture content data.
	CZ Hydraulic conductivity	m/yr	1892	1892	WHC-EP-0883, mean values for 200 Area soils.
	CZ "b" parameter	unitless	4.05	4.05	Derived from RESRAD Table E.2.
	Humidity in air	g/cm^3	8	8	RESRAD default.
	Evapo-transpiration coefficient	unitless	0.91	0.91	WDOH/320-015.
	Wind speed	m/s	3.4	3.4	PNNL-13033.
	Precipitation	m/yr	0.16	0.16	Based on 16 cm (6.3-in.) average annual rainfall (DOE/RL-92-19).
	Irrigation	m/yr	0	0	
	Irrigation mode		-	-	
	Runoff coefficient	unitless	0.2	0.2	RESRAD default.
	Watershed area for nearby stream or pond	m^2	1.0 E+06	1.0 E+06	RESRAD default.
	Accuracy for water/soil computations	unitless	0.001	0.001	RESRAD default.
Saturated zone (SZ) hydrologic data	Density of SZ	g/cm3	2.1	2.1	Site-specific value based on RI results.
	SZ total porosity	unitless	0.21	0.21	Assumed equal to effective porosity.
	SZ effective porosity	unitless	0.21	0.21	WHC-EP-0883; assumed to be equal to mean effective porosity for 200 Area soils.
	SZ field capacity	unitless	0.046	0.046	Based on residual water content.
	SZ hydraulic conductivity	m/yr	1577	1577	WHC-EP-0883; mean value for 200 Area soils, based on conductivity of last vadose stratum intersecting water table.

Table D-7. Parameters Used for RESRAD Analysis, 216-S-7 Crib - Industrial Scenario. (4 Pages)

Input Field Description	Parameter	Units	Industrial Scenario	Groundwater Protection	Rationale and Citation
Saturated zone (SZ) hydrologic data	SZ hydraulic gradient	unitless	0.0013	0.0013	PNNL-14187
	SZ "b" parameter	unitless	4.05	4.05	Derived from RESRAD Table E.2.
	Water table drop rate	m/yr	0.001	0.001	RESRAD default.
	Well pump intake depth below water table	m	4.6	4.6	Typical RCRA well screen length (DOE/RL-2002-42).
	Nondispersion or mass-balance transport model	--	ND	ND	Per RESRAD guidance, nondispersion (ND) model used to model potential GW impacts for sites >1000 m^2.
	Well pumping rate	m^3/yr	250	250	RESRAD default.
Uncontaminated unsaturated zone data	Number of unsaturated strata below CZ	--	5	2 1 (tritium)	Site-specific values based on RI results.
	Thickness of unsaturated strata	m	8.8, 4.6, 4.3, 28.3, 16.6	25.6, 16.6 4.2 m (tritium)	Site-specific values based on RI results.
	Soil Density	g/cm3	2.0, 2.3, 2.0, 1.47, 2.1	1.47, 2.1	Site-specific values based on RI results.
	Total porosity	unitless	0.245, 0.13, 0.245, 0.445, 0.21	0.445, 0.21	See Cover and CZ inputs.
	Effective porosity	unitless	0.245, 0.13, 0.245, 0.445, 0.21	0.445, 0.21	See Cover and CZ inputs.
	Field capacity	unitless	0.11, 0.062, 0.11, 0.21, 0.046	0.21, 0.046	Based on residual water content: WHC-EP-0883, mean value for 200 Area Soils.
	Hydraulic conductivity	m/yr	1892, 4730, 1892, 315, 1577	315, 1577	See Cover and CZ inputs.
	Soil-specific "b" parameter	unitless	4.05, 4.05, 4.05, 4.38, 4.05	4.38, 4.05	Derived from RESRAD Table E.2.
Occupancy	Inhalation rate	m^3/yr	7,300	NA	WDOH/320-015
	Mass loading for inhalation	g/m^3	0.0001	0.0001	WDOH/320-015
	Exposure duration	yr	25	25	WDOH/320-015
	Indoor dust filtration factor	unitless	0.4	NA	RESRAD default.
	External gamma shielding factor	unitless	0.8	NA	WDOH/320-015.

Table D-7. Parameters Used for RESRAD Analysis, 216-S-7 Crib - Industrial Scenario. (4 Pages)

Input Field Description	Parameter	Units	Industrial Scenario	Groundwater Protection	Rationale and Citation
	Indoor time fraction	unitless	0.137	NA	200 Area industrial scenario; on site 2,000 h/yr; indoors 60% (DOE/RL-2002-42).
	Outdoor time fraction	unitless	0.091	NA	200 Area industrial scenario; on site 2000 h/yr; outdoors 40% (DOE/RL-2002-42).
	Shape factor	unitless	Circular	NA	Shape factor area is used by RESRAD for Area value in CZ field.
Ingestion pathway; dietary data	Soil ingestion rate	g/yr	36.5	NA	WDOH/320-015.
	Drinking water intake	L/yr	NA	730	WDOH/320-015. Only used to screen transport of COCs to groundwater.
	Drinking water contaminated fraction		1	1	RESRAD default; only used to screen transport of COCs to groundwater.
Ingestion pathway; nondietary data	Depth of soil mixing layer	m	0.15	0.15	RESRAD default.
	Drinking water fractional use		1	1	RESRAD default; only used to screen transport of COCs to groundwater.
Storage Times	Well water storage time	days	1	1	RESRAD default; only used to screen transport of COCs to groundwater.

From Appendix A.
D&D-25034, *200-PW-2 Operable Unit Borehole Summary Report for the 216-S-7 Crib.*
DOE/RL-92-19, *200 East Groundwater Aggregate Area Management Study.*
DOE/RL-2000-60, *Uranium Rich/General Process Condensate and Process Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan; Includes 200-PW-2 and 200-PW-4 Operable Units*
DOE/RL-2002-42, *Remedial Investigation Report for the 200-TW-1 and 200-TW-2 Operable Units (includes the 200-PW-5 Operable Unit).*
PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site.*
PNNL-13033, *Recharge Data Package for the Immobilized Low-Activity Waste 2001 Performance Assessment.*
PNNL-14187, Hanford Site Groundwater Monitoring for Fiscal Year 2002.
Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq.
WDOH/320-015, *Hanford Guidance for Radiological Cleanup.*
WHC-EP-0883, *Variability and Scaling of Hydraulic Properties for 200 Area Soils.*

COC = contaminant of concern.
COPC = contaminant of potential concern.
CZ = contaminated zone.
GW = groundwater.
NA = not applicable.
ND = nondispersion.
RCRA = *Resource Conservation and Recovery Act of 1976.*
RESRAD = RESidual RADioactivity (ANL/EAD-4, User's Manual for RESRAD, Version 6).
RI = remedial investigation.
SZ = saturated zone.
-- = not applicable

Table D-8. RESRAD Dose Results – Industrial, Without Cover. (2 Pages)

Total Dose (mrem/yr)	Time (years)	Primary Radionuclide	Percentage of Total Dose	Primary Pathway
207-A South Retention Basin				
2.2	0	Radium-226	71%	External
2.2	1	Radium-226	71%	External
2.1	10	Radium-226	74%	External
1.9	30	Radium-226	80%	External
1.7	100	Radium-226	87%	External
1.7	150	Radium-226	86%	External
1.7	250	Radium-226	82%	External
1.7	500	Radium-226	70%	External
1.7	1,000	Radium-226	52%	External
216-A-10 Crib				
5.0	0	Potassium-40	68%	External
5.0	1	Potassium-40	68%	External
5.0	10	Potassium-40	67%	External
5.0	30	Potassium-40	67%	External
4.9	100	Potassium-40	68%	External
4.9	150	Potassium-40	68%	External
4.7	250	Potassium-40	69%	External
4.5	500	Potassium-40	71%	External
4.0	1,000	Potassium-40	75%	External
216-A-19 Trench				
1.4	0	Uranium-238	83%	External
1.4	1	Uranium-238	83%	External
1.3	10	Uranium-238	84%	External
1.3	30	Uranium-238	85%	External
1.1	100	Uranium-238	86%	External
1.0	150	Uranium-238	87%	External
0.85	250	Uranium-238	87%	External
0.55	500	Uranium-238	86%	External
0.24	1,000	Uranium-238	82%	External
216-A-36B Crib				
Not modeled – depth of clean cover >7.6 m (25 ft)				
216-A-37-1 Crib				
1.8 E-02	0	Cesium-137	73%	External
1.8 E-02	1	Cesium-137	74%	External
1.4 E-02	10	Cesium-137	77%	External
8.2 E-03	30	Cesium-137	81%	External

Table D-8. RESRAD Dose Results – Industrial, Without Cover. (2 Pages)

Total Dose (mrem/yr)	Time (years)	Primary Radionuclide	Percentage of Total Dose	Primary Pathway
1.6 E-03	100	Cesium-137	83%	External
4.9 E-04	150	Cesium-137	84%	External
4.8 E-05	250	Cesium-137	85%	External
1.5 E-07	500	Cesium-137	87%	External
1.4 E-12	1,000	Cesium-137	91%	External
216-B-12 Crib				
0.0088	0	Thorium-230	91%	Inhalation; Soil Ingestion
0.0098	1	Thorium-230	81%	Inhalation; Soil Ingestion
0.019	10	Thorium-230	57%	External
0.039	30	Thorium-230	79%	External
0.11	100	Thorium-230	91%	External
0.16	150	Thorium-230	93%	External
0.25	250	Thorium-230	95%	External
0.46	500	Thorium-230	96%	External
0.79	1,000	Thorium-230	96%	External
216-S-7 Crib				
0.024	0	Cesium-137	88%	External
0.023	1	Cesium-137	90%	External
0.017	10	Cesium-137	98%	External
0.011	30	Cesium-137	100%	External
0.0022	100	Cesium-137	100%	External
6.8E-04	150	Cesium-137	100%	External
6.7E-05	250	Cesium-137	100%	External
2.1E-07	500	Cesium-137	100%	External
2.0E-12	1000	Cesium-137	100%	External

RESRAD modeling results from Tables 4-15, 4-16, and 4-18 through 4-25 of DOE/RL-2004-25, *Remedial Investigation for the 200-PW-2 Uranium-Rich Process Waste Group and 200-PW-4 General Process Condensate Group Operable Unit.*

RESRAD = RESidual RADioactivity, ANL 2002, *RESRAD for Windows*, Version 6.21.

Table D-9. RESRAD Risk Results – Industrial, Without Cover. (2 Pages)

Total Risk	Time (years)	Primary Radionuclide	Percentage of Total Dose	Primary Pathway
207-A South Retention Basin				
4.0 E-05	0	Radium-226	75%	External
4.0 E-05	1	Radium-226	76%	External
4.0 E-05	10	Radium-226	78%	External
4.0 E-05	30	Radium-226	83%	External
3.0 E-05	100	Radium-226	88%	External
3.0 E-05	150	Radium-226	86%	External
3.0 E-05	250	Radium-226	82%	External
3.0 E-05	500	Radium-226	70%	External
3.0 E-05	1,000	Radium-226	52%	External
216-A-10 Crib				
9.0 E-05	0	Potassium-40	68%	External
9.0 E-05	1	Potassium-40	68%	External
9.0 E-05	10	Potassium-40	68%	External
9.0 E-05	30	Potassium-40	68%	External
9.0 E-05	100	Potassium-40	68%	External
9.0 E-05	150	Potassium-40	69%	External
9.0 E-05	250	Potassium-40	69%	External
8.0 E-05	500	Potassium-40	71%	External
8.0 E-05	1,000	Potassium-40	75%	External
216-A-19 Trench				
2.0 E-05	0	Uranium-238	83%	External
2.0 E-05	1	Uranium-238	84%	External
2.0 E-05	10	Uranium-238	84%	External
2.0 E-05	30	Uranium-238	85%	External
2.0 E-05	100	Uranium-238	87%	External
1.0 E-05	150	Uranium-238	87%	External
1.0 E-05	250	Uranium-238	87%	External
8.0 E-06	500	Uranium-238	86%	External
3.0 E-06	1,000	Uranium-238	81%	External
216-A-36B Crib				
Not modeled – depth of clean cover >7.6 m (25 ft)				

Table D-9. RESRAD Risk Results – Industrial, Without Cover. (2 Pages)

Total Risk	Time (years)	Primary Radionuclide	Percentage of Total Dose	Primary Pathway
216-A-37-1 Crib				
5.0 E-07	0	Tritium	58%	Inhalation
5.0 E-07	1	Tritium	57%	Inhalation
3.0 E-07	10	Cesium-137; Tritium	91%	External; Inhalation
1.0 E-07	30	Cesium-137	64%	External
2.0 E-08	100	Cesium-137	84%	External
7.0 E-09	150	Cesium-137	85%	External
7.0 E-10	250	Cesium-137	86%	External
2.0 E-12	500	Cesium-137	88%	External
2.0 E-17	1,000	Cesium-137	91%	External
216-B-12 Crib				
3.0 E-07	0	Thorium-230	85%	External
3.0 E-07	1	Thorium-230	87%	External
5.0 E-07	10	Thorium-230	92%	External
8.0 E-07	30	Thorium-230	95%	External
2.0 E-06	100	Thorium-230	97%	External
3.0 E-06	150	Thorium-230	98%	External
5.0 E-06	250	Thorium-230	98%	External
9.0 E-06	500	Thorium-230	98%	External
1.0 E-05	1,000	Thorium-230	98%	External
216-S-7 Crib				
5E-07	0	Cesium-137 Tritium	64% 36%	External Inhalation
4E-07	1	Cesium-137 Tritium	69% 31%	External Inhalation
3E-07	10	Cesium-137	94%	External
2E-07	30	Cesium-137	100%	External
3E-08	100	Cesium-137	100%	External
1E-08	150	Cesium-137	100%	External
1E-09	250	Cesium-137	100%	External
3E-12	500	Cesium-137	100%	External
3E-17	1,000	Cesium-137	100%	External

RESRAD modeling results from Tables 4-15, 4-16, and 4-18 through 4-25 of DOE/RL-2004-25, *Remedial Investigation for the 200-PW-2 Uranium-Rich Process Waste Group and 200-PW-4 General Process Condensate Group Operable Unit.*

RESRAD = RESidual RADioactivity, ANL 2002, *RESRAD for Windows*, Version 6.21.

Table D-10. RESRAD Dose Results – Industrial, With Existing Cover.

Total Dose (mrem/yr)	Time (years)	Primary Radionuclide	Percentage of Total Dose	Primary Pathway
207-A South Retention Basin				
0.57	0	Radium-226	74%	External
0.58	1	Radium-226	75%	External
0.63	10	Radium-226	77%	External
0.79	30	Radium-226	81%	External
1.7	100	Radium-226	87%	External
1.6	150	Radium-226	86%	External
1.6	250	Radium-226	82%	External
1.6	500	Radium-226	70%	External
1.5	1,000	Radium-226	51%	External
216-A-10 Crib				
Not modeled with cover – existing fill is >7.6 m (25 ft) and is contaminated.				
216-A-19 Trench				
0	0	NA	NA	NA
0	1	NA	NA	NA
0	10	NA	NA	NA
0	30	NA	NA	NA
0	100	NA	NA	NA
6.5 E-30	150	Uranium-234	100%	External
1.6 E-28	250	Uranium-238	57%	External
1.2 E-26	500	Uranium-234	72%	External
3.5 E-23	1,000	Uranium-234	89%	External
216-A-36B Crib				
Not modeled with or without cover – depth of clean cover >7.6 m (25 ft)				
216-A-37-1 Crib				
1.1 E-19	0	Cesium-137	100%	External
1.1 E-19	1	Cesium-137	100%	External
9.9 E-20	10	Cesium-137	100%	External
8.7 E-20	30	Cesium-137	100%	External
5.4 E-20	100	Cesium-137	100%	External
3.9 E-20	150	Cesium-137	100%	External
2.0 E-20	250	Cesium-137	100%	External
3.8 E-21	500	Cesium-137	100%	External
1.3 E-22	1,000	Cesium-137	100%	External
216-B-12 Crib				
Not modeled with cover – existing fill is >7.6 m (25 ft) and is contaminated.				
216-S-7 Crib				
Not modeled with cover – existing fill is >6.4 m (21 ft) and is slightly contaminated.				

RESRAD modeling results from Tables 4-15, 4-16, and 4-18 through 4-25 of DOE/RL-2004-25, *Remedial Investigation for the 200-PW-2 Uranium-Rich Process Waste Group and 200-PW-4 General Process Condensate Group Operable Unit.*

NA = not applicable; no dose calculated for this time.

RESRAD = RESidual RADioactivity, ANL 2002, *RESRAD for Windows*, Version 6.21.

Table D-11. RESRAD Risk Results – Industrial, With Existing Cover.

Total Risk	Time (years)	Primary Radionuclide	Percentage of Total Dose	Primary Pathway
207-A South Retention Basin				
1.0 E-05	0	Radium-226	78%	External
1.0 E-05	1	Radium-226	78%	External
1.0 E-05	10	Radium-226	80%	External
2.0 E-05	30	Radium-226	84%	External
3.0 E-05	100	Radium-226	87%	External
3.0 E-05	150	Radium-226	86%	External
3.0 E-05	250	Radium-226	82%	External
3.0 E-05	500	Radium-226	70%	External
3.0 E-05	1,000	Radium-226	51%	External
216-A-10 Crib				
Not modeled with cover – existing fill is >7.6 m (25 ft) and is contaminated.				
216-A-19 Trench				
0	0	NA	NA	NA
0	1	NA	NA	NA
0	10	NA	NA	NA
0	30	NA	NA	NA
0	100	NA	NA	NA
0	150	NA	NA	NA
0	250	NA	NA	NA
0	500	NA	NA	NA
8.0 E-28	1,000	Uranium-234	92%	External
216-A-36B Crib				
Not modeled with or without cover – depth of clean cover >7.6 m (25 ft)				
216-A-37-1 Crib				
2.0 E-24	0	Cesium-137	100%	External
2.0 E-24	1	Cesium-137	100%	External
2.0 E-24	10	Cesium-137	100%	External
1.0 E-24	30	Cesium-137	100%	External
9.0 E-25	100	Cesium-137	100%	External
7.0 E-25	150	Cesium-137	100%	External
3.0 E-25	250	Cesium-137	100%	External
7.0 E-26	500	Cesium-137	100%	External
2.0 E-27	1,000	Cesium-137	100%	External
216-B-12 Crib				
Not modeled with cover – existing fill is >7.6 m (25 ft) and is contaminated.				
216-S-7 Crib				
Not modeled with cover – existing fill is >6.4 m (21 ft) and is slightly contaminated.				

RESRAD modeling results from Tables 4-15, 4-16, and 4-18 through 4-25 of DOE/RL-2004-25, Remedial Investigation for the 200-PW-2 Uranium-Rich Process Waste Group and 200-PW-4 General Process Condensate Group Operable Unit.

NA = not applicable; no dose calculated for this time.

RESRAD = RESidual RADioactivity, ANL 2002, *RESRAD for Windows*, Version 6.21.

Table D-12. Comparison of Shallow-Zone Soil Exposure Point Concentrations that Exceed Background Concentrations to Ecological Screening Levels for Nonradionuclides. (5 Pages)

Constituent Name	Constituent Class	Units	Exposure Point Concentration	90th Percentile Background Concentration	Does the EPC Exceed Background?	Soil Indicator Value[a] (Wildlife)	COEC?	Justification
207-A South Retention Basin								
Arsenic	METAL	mg/kg	9.98	6.47	Yes	7	Yes	Exceeds background and screening value
Silver	METAL	mg/kg	5.01	0.73	No	2[b]	Yes	Exceeds screening value and background
2,4-dichlorophenoxy-acetic acid	Pest/PCB	µg/kg	7.10	--	NA	NA	Yes	Detected, no background or screening value. Requires further evaluation[c]
2-(2,4,5-trichlorophenoxy)-propionic acid	Pest/PCB	µg/kg	3.30	--	NA	NA	Yes	Detected, no background or screening value. Requires further evaluation[c]
Butylbenzyl phthalate	SVOC	µg/kg	110.0	--	NA	NA	Yes	Detected, no background or screening value. Requires further evaluation[c]
Diethylphthalate	SVOC	µg/kg	320.0	--	NA	100,000[b]	No	Less than screening value
216-A-10 Crib								
Antimony	METAL	mg/kg	0.48	--	NA	5[b]	No	Less than screening value
Boron	METAL	mg/kg	0.89	--	NA	0.5[b]	Yes	Exceeds screening value
Beta-BHC	Pest/PCB	µg/kg	7.00	--	NA	NA	Yes	Detected, no background or screening value. Requires further evaluation[c]

Table D-12. Comparison of Shallow-Zone Soil Exposure Point Concentrations that Exceed Background Concentrations to Ecological Screening Levels for Nonradionuclides. (5 Pages)

Constituent Name	Constituent Class	Units	Exposure Point Concentration	90th Percentile Background Concentration	Does the EPC Exceed Background?	Soil Indicator Value[a] (Wildlife)	COEC?	Justification
216-A-19 Trench								
Arsenic	METAL	mg/kg	7.00	6.47	Yes	7	No	Did not exceed screening level.
Boron	METAL	mg/kg	38.9	--	NA	0.5[b]	Yes	Exceeds screening value
Thallium	METAL	mg/kg	0.068	--	NA	1[b]	No	Less than screening value
Uranium	METAL	mg/kg	129	3.21	Yes	5[b]	Yes	Exceeds background and screening value
Vanadium	METAL	mg/kg	96.1	85.1	Yes	2[b]	Yes	Exceeds background and screening value
Bis(2-ethylhexyl)-phthalate	SVOC	µg/kg	660	--	NA	NA	Yes	Detected, no background or screening value. Requires further evaluation[c]
Tributyl phosphate	SVOC	µg/kg	280,000	--	NA	NA	Yes	Detected, no background or screening value. Requires further evaluation[c]
TPH -diesel range	TPH	µg/kg	230,000	--	NA	6,000,000	No	Less than screening value
216-A-36B Crib								
Silver	METAL	mg/kg	3.12	0.73	Yes	2[b]	Yes	Exceeds background and screening value
Diethylphthalate	SVOC	µg/kg	280	--	NA	100,000[b]	No	Less than screening value

Table D-12. Comparison of Shallow-Zone Soil Exposure Point Concentrations that Exceed Background Concentrations to Ecological Screening Levels for Nonradionuclides. (5 Pages)

Constituent Name	Constituent Class	Units	Exposure Point Concentration	90th Percentile Background Concentration	Does the EPC Exceed Background?	Soil Indicator Value[a] (Wildlife)	COEC?	Justification
216-A-37-1 Crib								
Barium	METAL	mg/kg	165	132	Yes	102	Yes	Exceeds background and screening value
Boron	METAL	mg/kg	0.51	--	NA	0.5[b]	Yes	Exceeds screening value
Manganese	METAL	mg/kg	547	512	Yes	1,500	No	Less than screening value
Thallium	METAL	mg/kg	0.88	--	NA	1[b]	No	Less than screening value
Acetone	VOC	µg/kg	13.0	--	NA	NA	Yes	Detected, no background or screening value. Requires further evaluation[c]
Bis(2-ethylhexyl) phthalate	SVOC	µg/kg	21.0	--	NA	NA	Yes	Detected, no background or screening value. Requires further evaluation[c]
Diethylphthalate	SVOC	µg/kg	650	--	NA	100,000[b]	No	Less than screening value
Tributyl phosphate	SVOC	µg/kg	45.0	--	NA	NA	Yes	Detected, no background or screening value. Requires further evaluation[c]
216-B-12 Crib								
Antimony	METAL	mg/kg	0.38	--	NA	5[b]	No	Less than screening value
Arsenic	METAL	mg/kg	7.30	6.47	Yes	7	Yes	Exceeds background and screening value
Boron	METAL	mg/kg	1.30	--	NA	0.5[b]	Yes	Exceeds screening value
Bis(2-ethylhexyl) phthalate	SVOC	µg/kg	18.0	--	NA	NA	Yes	Detected, no background or screening value. Requires further evaluation[c]

Table D-12. Comparison of Shallow-Zone Soil Exposure Point Concentrations that Exceed Background Concentrations to Ecological Screening Levels for Nonradionuclides. (5 Pages)

Constituent Name	Constituent Class	Units	Exposure Point Concentration	90th Percentile Background Concentration	Does the EPC Exceed Background?	Soil Indicator Value[a] (Wildlife)	COEC?	Justification
Di-n-butylphthalate	SVOC	µg/kg	77.0	--	NA	200,000	No	Less than screening value
TPH-gasoline range	TPH	µg/kg	110	--	NA	5,000,000	No	Less than screening value
216-S-7 Crib								
Chromium VI	METAL	mg/kg	0.8	--	NA	NA	Yes	Detected, no background or screening value. Requires further evaluation[c]
Mercury (inorganic)	METAL	mg/kg	1.7	0.33	Yes	5.5	No	Less than screening value
Silver	METAL	mg/kg	3.95	0.73	Yes	2[b]	Yes	Exceeds background and screening value
4,4'-DDE	Pest/PCB	mg/kg	1.4	--	NA	750[d]	No	Less than screening value
4,4'-DDT	Pest/PCB	mg/kg	0.42	--	NA	750[d]	No	Less than screening value
Aldrin	Pest/PCB	mg/kg	0.81	--	NA	100	No	Less than screening value
Delta-BHC	Pest/PCB	mg/kg	1.2	--	NA	6000[e]	No	Less than screening value
Endosulfan II	Pest/PCB	mg/kg	0.46	--	NA	350[f]	No	Detected, much less than LANL screening value[f]
Endosulfan Sulfate	Pest/PCB	mg/kg	1.2	--	NA	350[f]	No	Detected, much less than LANL screening value[f]
Diethyl phthalate	SVOC	mg/kg	660	--	NA	100,000	No	Less than screening value
Di-n-butylphthalate	SVOC	mg/kg	790	--	NA	200,000	No	Less than screening value

Shading indicates that analyte was retained as a contaminant of ecological concern.

Ecological screening results from Tables 4-32 through 4-37 of DOE/RL-2004-25, *Remedial Investigation for the 200-PW-2 Uranium-Rich Process Waste Group and 200-PW-4 General Process Condensate Group Operable Unit.*

[a]Unless otherwise footnoted, screening values represent WAC-173-340-900, "Tables," Table 749-3, "Ecological Indicator Soil Concentration (mg/kg) for Protection of Terrestrial Plants and Animals."

[b]No WAC-173-340-900, Table 749-3, terrestrial wildlife value available; screening value is lowest of WAC-173-340-900, Table 749-3, soil values for plants and biota.

Table D-12. Comparison of Shallow-Zone Soil Exposure Point Concentrations that Exceed Background Concentrations to Ecological Screening Levels for Nonradionuclides. (5 Pages)

Constituent Name	Constituent Class	Units	Exposure Point Concentration	90th Percentile Background Concentration	Does the EPC Exceed Background?	Soil Indicator Value[a] (Wildlife)	COEC?	Justification

[c]This evaluation is provided in Section 2.6 of this feasibility study.
[d]Screening value represents terrestrial wildlife value for Total DDTs from WAC 173-340-900, Table 749-3.
[e]Soil indicator for all hexachlorocyclohexanes (BHC) from WAC 173-340-900, Table 749-3.
[f]Screening value represents soil indicator value from LANL, 2004, *ECORISK Database*, Release 2.1.

BHC = beta-1,2,3,4,5,6-hexachlorocyclohexane.
COEC = contaminant of ecological concern.
CONV = conventional parameter.
DDE = dichlorodiphenyldichloroethylene.
DDT = dichlorodiphenyltrichloroethane.
EPC = exposure-point concentration.
LANL = Los Alamos National Laboratory.
NA = not applicable/not available.
ND = not detected.
PEST/PCB = pesticide/polychlorinated biphenyl.
SVOC = semivolatile organic compound.
TPH = total petroleum hydrocarbon.
VOC = volatile organic compound.
WAC = *Washington Administrative Code*.

Table D-13. Comparison of Shallow-Zone Soil Exposure-Point Concentrations to Background and to Ecological Screening Values for Radionuclides. (12 Pages)

Constituent Name	No. of Samples	No. of Detects	FOD	Exposure Point Concentration (pCi/g) [a]	90th Percentile Background Concentration (pCi/g) [a]	Exceeds Background?	Biota Concentration Guide [b]	Dose Fraction (EPC/BCG)	COEC?	Justification
207-A South Retention Basin										
Americium-241	13	8	62%	0.049	--	NA	3,890	1.26 E-05	No	Less than BCG
Carbon-14	13	0	0%	ND	--	NA	--	NA	No	Not detected
Cesium-137	13	9	69%	1.07	--	Yes	21	5.15 E-02	No	Less than BCG
Cobalt-60	13	0	0%	ND	--	No	692	NA	No	Not detected
Europium-152	13	0	0%	ND	--	NA	1,520	NA	No	Not detected
Europium-154	13	0	0%	ND	--	No	1,290	NA	No	Not detected
Europium-155	13	1	8%	0.077	--	Yes	15,800	4.86 E-06	No	Less than BCG
Iodine-129	13	0	0%	ND	--	NA	5,670	NA	No	Not detected
Neptunium-237	13	0	0%	ND	--	NA	--	NA	No	Not detected
Nickel-63	13	0	0%	ND	--	NA	--	NA	No	Not detected
Niobium-94	13	1	8%	0.032	--	NA	--	NA	Yes	Detected, no background or BCG. Requires further evaluation.
Plutonium-238	13	0	0%	ND	--	No	--	NA	No	Not detected
Plutonium-239/240	13	1	8%	0.012	--	No	6,110	1.96 E-06	No	Less than BCG
Radium-226	13	13	100%	0.859	0.815	Yes	51	1.70 E-02	No	Less than BCG
Radium-228	13	13	100%	1.10	1.32	No	44	2.51 E-02	No	Less than background and BCG
Technetium-99	13	0	0%	ND	--	NA	4,490	NA	No	Not detected

Table D-13. Comparison of Shallow-Zone Soil Exposure-Point Concentrations to Background and to Ecological Screening Values for Radionuclides. (12 Pages)

Constituent Name	No. of Samples	No. of Detects	FOD	Exposure Point Concentration (pCi/g) [a]	90th Percentile Background Concentration (pCi/g) [a]	Exceeds Background?	Biota Concentration Guide [b]	Dose Fraction (EPC/BCG)	COEC?	Justification
Thorium-230	13	11	85%	1.26	1.10	Yes	--	NA	Yes	Detected above background, no BCG. Requires further evaluation.
Thorium-232	13	12	92%	0.722	1.32	No	1,510	4.79 E-04	No	Less than BCG
Tin-126	13	0	0%	ND	--	NA	--	NA	No	Not detected
Total Radioactive Strontium	13	7	54%	1.40	--	Yes	23	6.23E-02	No	Less than BCG
Tritium	13	9	69%	16.6	--	NA	174,000	9.54 E-05	No	Less than BCG
Uranium-234	13	13	100%	0.24	1.10	No	5,130	4.68 E-05	No	Less than background and BCG
Uranium-235	13	12	92%	0.026	0.109	No	2,770	9.38 E-06	No	Less than background and BCG
Uranium-238	13	13	100%	0.27	1.06	No	1,580	1.71 E-04	No	Less than background and BCG
207-A South Retention Basin, Dose Fractions Sum: Hazard Index for Constituents with BCGs = 0.157										
					216-A-10 Crib					
Americium-241	1	0	0%	ND	--	NA	3,890	NA	No	Not detected
Carbon-14	1	0	0%	ND	--	NA	--	NA	No	Not detected
Cesium-137	1	0	0%	ND	--	NA	--	NA	No	Not detected
Cobalt-60	1	0	0%	ND	--	No	21	NA	No	Not detected
Europium-152	1	0	0%	ND	--	No	692	NA	No	Not detected
					--	NA	1,520	NA	No	Not detected

Table D-13. Comparison of Shallow-Zone Soil Exposure-Point Concentrations to Background and to Ecological Screening Values for Radionuclides. (12 Pages)

Constituent Name	No. of Samples	No. of Detects	FOD	Exposure Point Concentration (pCi/g) [a]	90th Percentile Background Concentration (pCi/g) [a]	Exceeds Background?	Biota Concentration Guide [b]	Dose Fraction (EPC/BCG)	COEC?	Justification
Europium-154	1	0	0%	ND	--	No	1,290	NA	No	Not detected
Europium-155	1	0	0%	ND	--	No	15,800	NA	No	Not detected
Iodine-129	1	0	0%	ND	--	NA	5,670	NA	No	Not detected
Neptunium-237	1	1	100%	0.043	--	NA	--	NA	Yes	Detected, no background or BCG. Requires further evaluation.
Nickel-63	1	0	0%	ND	--	NA	--	NA	No	Not detected
Plutonium-238	1	0	0%	ND	--	No	--	NA	No	Not detected
Plutonium-239/240	1	0	0%	ND	--	No	6,110	NA	No	Not detected
Potassium-40	1	0	0%	18.700	16.6	Yes	--	NA	Yes	Exceeds background, no BCG. Requires further evaluation.
Radium-226	1	1	100%	0.820	0.815	Yes	51	1.62 E-02	No	Less than BCG
Radium-228	1	0	0%	ND	1.32	No	44	NA	No	Not detected
Strontium-90	1	0	0%	ND	--	No	23	NA	No	Not detected
Technetium-99	1	1	100%	ND	--	NA	4,490	NA	No	Not detected
Thorium-230	1	1	100%	0.481	1.10	No	--	NA	No	Less than background
Thorium-232	1	0	0%	0.481	1.32	No	1,510	3.19 E-04	No	Less than background and BCG
Tritium	1	0	0%	ND	--	NA	174,000	NA	No	Not detected

Table D-13. Comparison of Shallow-Zone Soil Exposure-Point Concentrations to Background and to Ecological Screening Values for Radionuclides. (12 Pages)

Constituent Name	No. of Samples	No. of Detects	FOD	Exposure Point Concentration (pCi/g)[a]	90th Percentile Background Concentration (pCi/g)[a]	Exceeds Background?	Biota Concentration Guide[b]	Dose Fraction (EPC/BCG)	COEC?	Justification
Uranium-234	1	1	100%	0.390	1.10	No	5,130	7.60 E-05	No	Less than background and BCG
Uranium-235	1	0	0%	ND	0.109	No	2,770	NA	No	Not detected
Uranium-238	1	1	100%	0.338	1.06	No	1,580	2.14 E-04	No	Less than background and BCG
216-A-10 Crib, Dose Fractions Sum: Hazard Index for Constituents with BCGs =0.017										
216-A-19 Trench										
Actinium-228	1	1	100%	0.523	--	NA	--	NA	Yes	Detected, no background or BCG. Requires further evaluation.
Americium-241	1	1	100%	0.081	--	NA	3,890	2.08 E-05	No	Less than BCG
Carbon-14	1	0	0%	ND	--	NA	--	NA	No	Not detected
Cesium-137	1	0	0%	ND	--	No	21	NA	No	Not detected
Cobalt-60	1	0	0%	ND	--	No	692	NA	No	Not detected
Europium-152	1	0	0%	ND	--	NA	1,520	NA	No	Not detected
Europium-154	1	0	0%	ND	--	No	1,290	NA	No	Not detected
Europium-155	1	1	100%	0.066	--	Yes	15,800	4.17 E-06	No	Less than BCG
Iodine-129	1	0	0%	ND	--	NA	5,670	NA	No	Not detected
Neptunium-237	1	0	0%	ND	--	NA	--	NA	No	Not detected

Table D-13. Comparison of Shallow-Zone Soil Exposure-Point Concentrations to Background and to Ecological Screening Values for Radionuclides. (12 Pages)

Constituent Name	No. of Samples	No. of Detects	FOD	Exposure Point Concentration (pCi/g)[a]	90th Percentile Background Concentration (pCi/g)[a]	Exceeds Background?	Biota Concentration Guide[b]	Dose Fraction (EPC/BCG)	COEC?	Justification
Nickel-63	1	1	100%	17.6	--	NA	--	NA	Yes	Detected, no background or BCG. Requires further evaluation.
Niobium-94	1	0	0%	ND	--	NA	--	NA	No	Not detected
Plutonium-238	1	0	0%	ND	--	NA	--	NA	No	Not detected
Plutonium-239/240	1	1	100%	0.180	--	Yes	6,110	2.94 E-05	No	Less than BCG
Radium-226	1	1	100%	0.439	0.815	No	51	8.68 E-03	No	Less than background and BCG
Radium-228	1	1	100%	0.523	1.32	No	44	1.19 E-02	No	Less than background and BCG
Technetium-99	1	1	100%	ND	--	NA	4,490	NA	No	Not detected
Thorium-230	1	1	100%	0.507	1.10	No	--	NA	No	Less than background
Thorium-232	1	1	100%	0.429	1.32	No	1,510	2.85 E-04	No	Less than background and BCG
Total Radioactive Strontium	1	1	100%	16.1	--	Yes	23	7.16 E-01	No	Less than BCG
Tritium	1	0	0%	ND	--	NA	174,000	NA	No	Not detected
Uranium-234	1	1	100%	6.00	1.10	Yes	5,130	1.17 E-03	No	Less than BCG
Uranium-235	1	1	100%	0.940	0.109	Yes	2,770	3.39 E-04	No	Less than BCG

Table D-13. Comparison of Shallow-Zone Soil Exposure-Point Concentrations to Background and to Ecological Screening Values for Radionuclides. (12 Pages)

Constituent Name	No. of Samples	No. of Detects	FOD	Exposure Point Concentration (pCi/g)[a]	90th Percentile Background Concentration (pCi/g)[a]	Exceeds Background?	Biota Concentration Guide[b]	Dose Fraction (EPC/BCG)	COEC?	Justification
Uranium-238	1	1	100%	51.0	1.06	Yes	1,580	3.23 E-02	No	Less than BCG
216-A-19 Trench, Dose Fractions Sum: Hazard Index for Constituents with BCGs =0.771										
216-A-36B Crib										
Americium-241	1	0	0%	ND	--	NA	3,890	NA	No	Not detected
Carbon-14	1	0	0%	ND	--	NA	--	NA	No	Not detected
Cesium-137	1	0	0%	ND	--	No	21	NA	No	Not detected
Cobalt-60	1	0	0%	ND	--	No	692	NA	No	Not detected
Europium-152	1	0	0%	ND	--	NA	1,520	NA	No	Not detected
Europium-154	1	0	0%	ND	--	No	1,290	NA	No	Not detected
Europium-155	1	0	0%	ND	--	No	15,800	NA	No	Not detected
Iodine-129	1	0	0%	ND	--	NA	5,670	NA	No	Not detected
Neptunium-237	1	0	0%	ND	--	NA	--	NA	No	Not detected
Nickel-63	1	0	0%	ND	--	NA	--	NA	No	Not detected
Niobium-94	1	0	0%	ND	--	NA	--	NA	No	Not detected
Plutonium-238	1	0	0%	ND	--	NA	--	NA	No	Not detected
Plutonium-239/240	1	0	0%	ND	--	No	6,110	NA	No	Not detected
Radium-226	1	1	100%	0.416	0.815	No	51	8.23 E-03	No	Less than background and BCG
Radium-228	1	1	100%	0.652	1.32	No	44	1.48 E-02	No	Less than background and BCG
Technetium-99	1	0	0%	ND	--	NA	4,490	NA	No	Not detected

Table D-13. Comparison of Shallow-Zone Soil Exposure-Point Concentrations to Background and to Ecological Screening Values for Radionuclides. (12 Pages)

Constituent Name	No. of Samples	No. of Detects	FOD	Exposure Point Concen-tration (pCi/g) [a]	90th Percentile Back-ground Concen-tration (pCi/g) [a]	Exceeds Back-ground?	Biota Concen-tration Guide [b]	Dose Fraction (EPC/BCG)	COEC?	Justification
Thorium-230	1	1	100%	0.935	1.10	No	--	NA	No	Less than background
Thorium-232	1	1	100%	0.425	1.32	No	1,510	2.82 E-04	No	Less than background and BCG
Total Radioactive Strontium	1	0	0%	ND	--	No	23	NA	No	Not detected
Tritium	1	0	0%	ND	--	NA	174,000	NA	No	Not detected
Uranium-234	1	1	100%	0.15	1.10	No	5,130	2.9 2E-05	No	Less than background and BCG
Uranium-235	1	1	100%	0.018	0.109	No	2,770	6.50 E-06	No	Less than background and BCG
Uranium-238	1	1	100%	0.17	1.06	No	1,580	1.08 E-04	No	Less than background and BCG
216-A-36B Crib, Dose Fractions Sum: Hazard Index for Constituents with BCGs =0.024										
216-A-37-1 Crib										
Americium-241	1	0	0%	ND	--	NA	3,890	NA	No	Not detected
Carbon-14	1	0	0%	ND	--	NA	--	NA	No	Not detected
Cesium-137	1	1	100%	0.113	--	No	21	5.44 E-03	No	Less than BCG
Cobalt-60	1	0	0%	ND	--	No	692	NA	No	Not detected
Europium-152	1	0	0%	ND	--	NA	1,520	NA	No	Not detected
Europium-154	1	0	0%	ND	--	No	1,290	NA	No	Not detected

Table D-13. Comparison of Shallow-Zone Soil Exposure-Point Concentrations to Background and to Ecological Screening Values for Radionuclides. (12 Pages)

Constituent Name	No. of Samples	No. of Detects	FOD	Exposure Point Concen-tration (pCi/g) [a]	90th Percentile Back-ground Concen-tration (pCi/g) [a]	Exceeds Back-ground?	Biota Concen -tration Guide [b]	Dose Fraction (EPC/BCG)	COEC?	Justification
Europium-155	1	0	0%	ND	--	No	15,800	NA	No	Not detected
Iodine-129	1	0	0%	ND	--	NA	5,670	NA	No	Not detected
Neptunium-237	1	0	0%	ND	--	NA	--	NA	No	Not detected
Nickel-63	1	0	0%	ND	--	NA	--	NA	No	Not detected
Niobium-94	1	0	0%	ND	--	NA	--	NA	No	Not detected
Plutonium-238	1	0	0%	ND	--	NA	--	NA	No	Not detected
Plutonium-239/240	1	0	0%	ND	--	No	--	NA	No	Not detected
	1	0	0%	ND	--	No	6,110	NA	No	Not detected
Radium-226	1	1	100%	0.406	0.815	No	51	8.03 E-03	No	Less than background and BCG
Radium-228	1	1	100%	0.581	1.32	No	44	1.32 E-02	No	Less than background and BCG
Technetium-99	1	0	0%	ND	--	NA	4,490	NA	No	Not detected
Thorium-230	1	0	0%	ND	1.10	No	--	NA	No	Not detected
Thorium-232	1	1	100%	0.393	1.32	No	1,510	2.61 E-04	No	Less than background and BCG
Tin-126	1	0	0%	ND	--	NA	--	NA	No	Not detected
Total Radioactive Strontium	1	1	100%	1.700	--	Yes	23	7.56 E-02	No	Less than BCG
Tritium	1	1	100%	134	--	NA	174,000	7.70 E-04	No	Less than BCG

Table D-13. Comparison of Shallow-Zone Soil Exposure-Point Concentrations to Background and to Ecological Screening Values for Radionuclides. (12 Pages)

Constituent Name	No. of Samples	No. of Detects	FOD	Exposure Point Concen-tration (pCi/g)[a]	90th Percentile Back-ground Concen-tration (pCi/g)[a]	Exceeds Back-ground?	Biota Concen-tration Guide[b]	Dose Fraction (EPC/BCG)	COEC?	Justification
Uranium-234	1	1	100%	0.17	1.10	No	5,130	3.31 E-05	No	Less than background and BCG
Uranium-235	1	1	100%	0.012	0.109	No	2,770	4.33 E-06	No	Less than background and BCG
Uranium-238	1	1	100%	0.18	1.06	No	1,580	1.14 E-04	No	Less than background and BCG
216-A-37-1 Crib, Dose Fractions Sum: Hazard Index for Constituents with BCGs = 0.103										
216-B-12 Crib										
Americium-241	1	0	0%	ND	--	NA	3,890	NA	No	Not detected
Carbon-14	1	0	0%	ND	--	NA	--	NA	No	Not detected
Cesium-137	1	0	0%	ND	--	No	21	NA	No	Not detected
Cobalt-60	1	0	0%	ND	--	No	692	NA	No	Not detected
Europium-152	1	0	0%	ND	--	NA	1,520	NA	No	Not detected
Europium-154	1	0	0%	ND	--	No	1,290	NA	No	Not detected
Europium-155	1	0	0%	ND	--	No	15,800	NA	No	Not detected
Iodine-129	1	0	0%	ND	--	NA	5,670	NA	No	Not detected
Neptunium-237	1	0	0%	ND	--	NA	--	NA	No	Not detected
Nickel-63	1	0	0%	ND	--	NA	--	NA	No	Not detected
Potassium-40	1	1	100%	14.2	16.6	No	--	NA	No	Not detected
Plutonium-238	1	0	0%	ND	--	No	--	NA	No	Not detected
Plutonium-239/240	1	0	0%	ND	--	No	6,110	NA	No	Less than BCG

Table D-13. Comparison of Shallow-Zone Soil Exposure-Point Concentrations to Background and to Ecological Screening Values for Radionuclides. (12 Pages)

Constituent Name	No. of Samples	No. of Detects	FOD	Exposure Point Concentration (pCi/g)[a]	90th Percentile Background Concentration (pCi/g)[a]	Exceeds Background?	Biota Concentration Guide[b]	Dose Fraction (EPC/BCG)	COEC?	Justification
Radium-226	1	1	100%	0.708	0.815	No	51	1.40 E-02	No	Less than background and BCG
Radium-228	1	0	0%	ND	1.32	No	44	NA	No	Not detected
Technetium-99	1	0	0%	ND	--	NA	4,490	NA	No	Not detected
Thorium-230	1	1	100%	1.190	1.10	Yes	--	NA	Yes	Above background, no BCG. Requires further evaluation.
Thorium-232	1	1	100%	0.716	1.32	No	1,510	4.75 E-04	No	Less than background and BCG
Tin-126	1	1	100%	0.742	--	NA	--	NA	Yes	Detected, no background or BCG. Requires further evaluation.
Total Radioactive Strontium	1	0	0%	ND	--	NA	23	NA	No	Not detected
Tritium	1	1	100%	8.28	--	NA	174,000	4.76 E-05	No	Less than BCG
Uranium-234	1	1	100%	0.605	1.10	No	5,130	1.18 E-04	No	Less than background and BCG
Uranium-235	1	0	0%	ND	0.109	No	2,770	NA	No	Not detected

Table D-13. Comparison of Shallow-Zone Soil Exposure-Point Concentrations to Background and to Ecological Screening Values for Radionuclides. (12 Pages)

Constituent Name	No. of Samples	No. of Detects	FOD	Exposure Point Concen-tration (pCi/g)[a]	90th Percentile Back-ground Concen-tration (pCi/g)[a]	Exceeds Back-ground?	Biota Concen-tration Guide[b]	Dose Fraction (EPC/BCG)	COEC?	Justification
Uranium-238	1	1	100%	0.628	1.06	No	1,580	3.98 E-04	No	Less than background and BCG
216-B-12 Crib, Dose Fractions Sum: Hazard Index for Constituents with BCGs =0.015										
216-S-7 Crib										
Americium-241	1	0	0%	ND	--	NA	3,890	NA	No	Not detected
Carbon-14	1	0	0%	ND	--	NA	--	NA	No	Not detected
Cesium-137	1	1	100%	0.037	0.191	No	21	0.00176	No	Less than background and BCG
Cobalt-60	1	0	0%	ND	0.0084	No	692	NA	No	Not detected
Europium-152	1	0	0%	ND	--	NA	--	NA	No	Not detected
Europium-154	1	0	0%	ND	0.03344	No	1,290	NA	No	Not detected
Europium-155	1	0	0%	ND	0.0539	No	15,800	NA	No	Not detected
Iodine-129	1	0	0%	ND	--	NA	5,670	NA	No	Not detected
Neptunium-237	1	0	0%	ND	--	NA	--	NA	No	Not detected
Nickel-63	1	0	0%	ND	--	NA	--	NA	No	Not detected
Plutonium-238	1	0	0%	ND	0.0047	No	--	NA	No	Not detected
Plutonium-239/240	1	0	0%	ND	0.019	No	6,110	NA	No	Not detected
Radium-226	1	1	100%	0.649	0.815	No	51	0.01273	No	Less than background and BCG
Radium-228	1	1	100%	0.719	1.32	No	44	0.01634	No	Less than background and BCG

Table D-13. Comparison of Shallow-Zone Soil Exposure-Point Concentrations to Background and to Ecological Screening Values for Radionuclides. (12 Pages)

Constituent Name	No. of Samples	No. of Detects	FOD	Exposure Point Concentration (pCi/g)[a]	90th Percentile Background Concentration (pCi/g)[a]	Exceeds Background?	Biota Concentration Guide[b]	Dose Fraction (EPC/BCG)	COEC?	Justification
Strontium-90	1	0	0%	ND	0.0178	No	23	NA	No	Not detected
Technetium-99	1	0	0%	ND	--	NA	4,490	NA	No	Not detected
Thorium-230	1	1	100%	0.527	1.10	No	--	NA	No	Less than background
Thorium-232	1	1	100%	0.772	1.32	No	1,510	0.000511	No	Less than background and BCG
Tritium	1	1	100%	184	--	NA	174,000	0.001057	No	Less than BCG
Uranium-233/234	1	1	100%	0.16	1.10	No	5,130	0.0000312	No	Less than background and BCG
Uranium-235	1	0	0%	ND	0.109	No	2,770	NA	No	Not detected
Uranium-238	1	1	100%	0.17	1.06	No	1,580	0.000108	No	Less than background and BCG
216-S-7 Crib, Dose Fractions Sum: Hazard Index for Constituents with BCGs = 0.033										

Shading indicates that analyte was retained as a contaminant of ecological concern.

[a] Ecological screening results and sample statistics from Tables 4-26 through 4-31 and Table A-1 of DOE/RL-2004-25, *Remedial Investigation for the 200-PW-2 Uranium-Rich Process Waste Group and 200-PW-4 General Process Condensate Group Operable Unit.*

[b] DOE/EH-0676, *RESRAD-BIOTA: A Tool for Implementing a Graded Approach to Biota Dose Evaluation*

[c] This evaluation is provided in Section 2.6 of this feasibility study.

BCG = biota concentration guide.
COEC = contaminant of ecological concern.
EPC = exposure-point concentration.
FOD = frequency of detection.
NA = not applicable/not available.
ND = not detected.

Table D-14. Comparison of Maximum Deep-Zone Soil Concentrations to Soil Risk-Based Concentrations for Groundwater Protection. (5 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Maximum Detected Result	GWP RBC[a]	Does Max Exceed GWP RBC?
207-A South Retention Basin								
CONV	Nitrate and nitrate/nitrite as N[b]	mg/kg	13	13	100%	20.9	4	Yes
CONV	Nitrate as N	mg/kg	13	11	85%	21.8	40	No
METAL	Arsenic	mg/kg	13	10	77%	9.98	0.034	Yes
METAL	Silver	mg/kg	13	2	15%	5.01	13.6	No
Pest/PCB	2-(2,4,5-trichlorophenoxy)propionic acid	µg/kg	6	1	17%	110	8.93 E+05	No
Pest/PCB	2,4-dichlorophenoxyacetic acid	µg/kg	6	1	17%	3.3	280	No
SVOC	Butylbenzylphthalate	µg/kg	13	1	8%	320	72,200	No
SVOC	Diethylphthalate	µg/kg	13	4	31%	7.1	321	No
216-A-10 Crib								
CONV	Nitrate and nitrate/nitrite as N[b]	mg/kg	14	11	79%	25.8	4	Yes
CONV	Nitrate as N	mg/kg	14	7	50%	26.8	40	No
CONV	Nitrite as N	mg/kg	14	2	14%	0.40	4	No
METAL	Antimony	mg/kg	14	4	29%	0.48	5.4	No
METAL	Boron	mg/kg	14	10	71%	1.0	210	No
METAL	Mercury	mg/kg	14	9	64%	1.25	2.09	No
METAL	Selenium	mg/kg	14	2	14%	3.57	5.2	No
METAL	Silver	mg/kg	14	2	14%	3.08	13.6	No
Misc.	Ethylene Glycol	µg/kg	14	1	7%	37.0	1.29 E+05	No
Misc.	Oil and Grease	µg/kg	10	2	20%	5.94 E+07	--	No screening level
Pest/PCB	Beta-1,2,3,4,5,6-hexachlorocyclohexane (B-BHC)	µg/kg	1	1	100%	7.0	2.27	Yes
SVOC	2-butoxyethanol (ethylene glycol monobutyl ether)	µg/kg	14	1	7%	25.6	16,100	No
SVOC	Bis(2-ethylhexyl)phthalate	µg/kg	14	2	14%	140.8	13,900	No
SVOC	Diethylphthalate	µg/kg	14	3	21%	390	72,200	No
SVOC	Pentachlorophenol	µg/kg	14	1	7%	20.4	11.5	Yes
SVOC	Tributyl phosphate	µg/kg	14	7	50%	2.00 E+06	6,180	Yes
TPH	TPH-gasoline range	µg/kg	14	1	7%	1,500	1.00 E+05	No
TPH	TPH-kerosene range	µg/kg	14	3	21%	2.40 E+07	--	No screening level

Table D-14. Comparison of Maximum Deep-Zone Soil Concentrations to Soil Risk-Based Concentrations for Groundwater Protection. (5 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Maximum Detected Result	GWP RBC[a]	Does Max Exceed GWP RBC?
TPH	TPH-motor oil	µg/kg	2	2	100%	9.00 E+04	2.00 E+06	No
VOC	2-butanone (methyl ethyl ketone)	µg/kg	13	2	15%	17.6	19,600	No
VOC	Acetone	µg/kg	13	4	31%	138	28,900	No
VOC	Methylene chloride	µg/kg	13	10	77%	29.1	21.8	Yes
VOC	Toluene	µg/kg	13	4	31%	250	7,270	No
216-A-19 Trench								
CONV	Fluoride	mg/kg	11	8	73%	5.62	24.1	No
CONV	Nitrate and nitrate/nitrite as N[b]	mg/kg	11	11	100%	1,120	4	Yes
CONV	Nitrate as N	mg/kg	11	11	100%	9,860	40	Yes
CONV	Nitrite as N	mg/kg	11	4	36%	1.12	4	No
CONV	Sulfate	mg/kg	11	11	100%	294	1,030	No
METAL	Arsenic	mg/kg	11	7	64%	7.00	0.034	Yes
METAL	Boron	mg/kg	11	4	36%	38.9	210	No
METAL	Manganese	mg/kg	11	11	100%	538	65.3	Yes
METAL	Molybdenum	mg/kg	11	2	18%	4.39	32.3	No
METAL	Thallium	mg/kg	11	6	55%	0.58	1.59	No
METAL	Uranium	mg/kg	11	7	64%	130	1.32	Yes
METAL	Vanadium	mg/kg	11	11	100%	108	2,240	No
METAL	Zinc	mg/kg	11	11	100%	85.6	5,970	No
SVOC	Bis(2-ethylhexyl)phthalate	µg/kg	11	4	36%	1,100	13,900	No
SVOC	Diethylphthalate	µg/kg	11	9	82%	1,000	72,200	No
SVOC	Tributyl phosphate	µg/kg	11	6	55%	280,000	6,180	Yes
TPH	TPH-diesel range	µg/kg	11	3	27%	3.0 E+05	2.00 E+06	No
216-A-36B Crib								
CONV	Nitrate and nitrate/nitrite as N[b]	mg/kg	11	11	100%	287	4	Yes
CONV	Nitrate as N	mg/kg	13	13	100%	289	40	Yes
CONV	Nitrite as N	mg/kg	13	1	8%	18.8	4	Yes
METAL	Antimony	mg/kg	13	2	15%	0.85	5.4	No
METAL	Boron	mg/kg	13	2	15%	5.8	210	No
METAL	Chromium (total)	mg/kg	13	12	92%	72.5	2,000	No
METAL	Mercury	mg/kg	13	7	54%	1.71	2.09	No
METAL	Molybdenum	mg/kg	2	1	50%	2.22	32.3	No

Table D-14. Comparison of Maximum Deep-Zone Soil Concentrations to Soil Risk-Based Concentrations for Groundwater Protection. (5 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Maximum Detected Result	GWP RBC [a]	Does Max Exceed GWP RBC?
METAL	Nickel	mg/kg	13	13	100%	58	130	No
METAL	Selenium	mg/kg	5	2	40%	0.51	5.2	No
METAL	Silver	mg/kg	13	5	38%	3.54	13.6	No
METAL	Thallium	mg/kg	2	1	50%	0.815	1.59	No
METAL	Uranium	mg/kg	20	15	75%	36.8	1.32	Yes
Misc.	Oil and Grease	µg/kg	11	1	9%	90,000	--	No screening level
Pest/PCB	Aroclor-1254	µg/kg	11	1	9%	13	485	No
SVOC	Diethylphthalate	µg/kg	13	5	38%	650	72,200	No
SVOC	Di-n-butylphthalate	µg/kg	13	1	8%	550	56,500	No
SVOC	Isophorone	µg/kg	13	2	15%	500	455	Yes
216-A-37-1 Crib								
CONV	Nitrate and nitrate/nitrite as N [b]	mg/kg	11	11	100%	489	4	Yes
CONV	Nitrate as N	mg/kg	21	21	100%	385	40	Yes
CONV	Nitrite as N	mg/kg	21	1	5%	1.66	4	No
METAL	Aluminum	mg/kg	10	10	100%	15,000	45.2	Yes
METAL	Antimony	mg/kg	21	4	19%	1.50	5.4	No
METAL	Barium	mg/kg	21	21	100%	193	923	No
METAL	Boron	mg/kg	21	11	52%	0.940	210	No
METAL	Chromium (total)	mg/kg	21	21	100%	23.5	2,000	No
METAL	Cobalt	mg/kg	10	10	100%	15.9	290	No
METAL	Lead	mg/kg	21	11	52%	13.1	270	No
METAL	Manganese	mg/kg	10	10	100%	652	65.3	Yes
METAL	Molybdenum	mg/kg	10	4	40%	1.95	32.3	No
METAL	Silver	mg/kg	21	6	29%	4.14	13.6	No
METAL	Thallium	mg/kg	10	7	70%	1.54	1.59	No
METAL	Vanadium	mg/kg	10	10	100%	122	2,240	No
SVOC	Bis(2-ethylhexyl)phthalate	µg/kg	17	6	35%	2,100	13,900	No
SVOC	Diethylphthalate	µg/kg	17	4	24%	760	72,200	No
SVOC	Di-n-butylphthalate	µg/kg	17	1	6%	19	56,500	No
SVOC	Tributyl phosphate	µg/kg	17	1	6%	45	6,180	No
VOC	Acetone	µg/kg	17	11	65%	14.9	28,900	No

Table D-14. Comparison of Maximum Deep-Zone Soil Concentrations to Soil Risk-Based Concentrations for Groundwater Protection. (5 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Maximum Detected Result	GWP RBC[a]	Does Max Exceed GWP RBC?
VOC	Methylene chloride	µg/kg	17	7	41%	4.87	21.8	No
216-B-12 Crib								
CONV	Nitrate and nitrate/nitrite as N[b]	mg/kg	16	16	100%	126	4	Yes
CONV	Nitrate as N	mg/kg	10	9	90%	165	40	Yes
CONV	Sulfate	mg/kg	10	8	80%	647	1,030	No
METAL	Antimony	mg/kg	10	4	40%	0.65	5.4	No
METAL	Arsenic	mg/kg	10	10	100%	7.30	0.034	Yes
METAL	Boron	mg/kg	10	4	40%	1.3	210	No
METAL	Chromium (total)	mg/kg	10	10	100%	30.4	2,000	No
METAL	Mercury	mg/kg	10	2	20%	1.31	2.09	No
METAL	Silver	mg/kg	10	1	10%	2.41	13.6	No
METAL	Uranium	mg/kg	10	10	100%	28	1.32	Yes
Pest/PCB	Aroclor-1254	µg/kg	2	1	50%	140	485	No
SVOC	Bis(2-ethylhexyl)phthalate	µg/kg	10	2	20%	20	13,900	No
SVOC	Diethylphthalate	µg/kg	10	5	50%	8,700	72,200	No
SVOC	Di-n-butylphthalate	µg/kg	10	3	30%	77	56,500	No
SVOC	Tributyl phosphate	µg/kg	10	4	40%	2,000	6,180	No
TPH	TPH-gasoline range	µg/kg	10	1	10%	110	1.00 E+05	No
216-S-7 Crib								
CONV	Nitrate and nitrate/nitrite as N[b]	mg/kg	1	1	100%	4.5E+01	4.0 E+00	Yes
CONV	Nitrate as N	mg/kg	13	13	100%	5.30E+01	4.00 E+01	Yes
METAL	Arsenic	mg/kg	13	6	46%	7.09E+00	3.40 E-02	Yes
METAL	Chromium (Total)	mg/kg	13	10	77%	1.46E+02	2.00 E+03	No
METAL	Copper	mg/kg	13	13	100%	5.21E+01	2.63 E+02	No
METAL	Hexavalent Chromium	mg/kg	13	4	31%	8.00E-01	1.84 E+01	No
METAL	Mercury	mg/kg	13	2	15%	1.70E+00	2.09 E+00	No
METAL	Nickel	mg/kg	13	13	100%	8.24E+01	1.30 E+02	No
METAL	Silver	mg/kg	13	2	15%	3.95E+00	1.36 E+01	No
METAL	Uranium (total)	mg/kg	13	8	62%	4.63E+02	1.32 E+00	Yes
Pest/PCB	4,4'-DDE (Dichlorodiphenyldichloroethylene)	mg/kg	1	1	100%	1.40E-03	4.46 E-01	No
Pest/PCB	4-4'-DDT (Dichlorodiphenyltrichloroethane)	mg/kg	1	1	100%	4.20E-04	3.49 E+00	No
Pest/PCB	Aldrin	mg/kg	1	1	100%	8.10E-04	5.04 E-03	No

Table D-14. Comparison of Maximum Deep-Zone Soil Concentrations to Soil Risk-Based Concentrations for Groundwater Protection. (5 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Maximum Detected Result	GWP RBC[a]	Does Max Exceed GWP RBC?
SVOC	Diethylphthalate	mg/kg	7	7	100%	6.60E-01	7.22 E+01	No
SVOC	Di-n-butylphthalate	mg/kg	12	12	100%	1.10E+00	5.65 E+01	No
VOC	Acetone	mg/kg	13	2	15%	1.60E-02	2.89 E+01	No
VOC	Bromomethane	mg/kg	13	2	15%	1.10E-03	5.18 E-03	No
VOC	Methylene chloride	mg/kg	13	4	31%	1.36E-02	2.18 E-02	No

Constituent statistics, analytical and screening results from Tables 4-9, 4-11, and A-1 of DOE/RL-2004-25, *Remedial Investigation for the 200-PW-2 Uranium-Rich Process Waste Group and 200-PW-4 General Process Condensate Group Operable Unit.*

[a] WAC 173-340-747, "Deriving Soil Concentrations for Ground Water Protection," calculations.

[b] RBC for nitrite used as screening level for nitrate/nitrite.

CONV = conventional parameter.
GWP = groundwater protection.
PEST/PCB = pesticide/polychlorinated biphenyl.
RBC = risk-based concentration.
SVOC = semivolatile organic compound.
TPH = total petroleum hydrocarbons.
VOC = volatile organic compound.

Table D-15. RESRAD Dose Results for Groundwater Protection.

Total Dose* (mrem/yr)	Time (years)	Primary Radionuclide	Percentage of Total Dose	Primary Pathway
207-A South Retention Basin				
--	0	--	--	Drinking Water
--	30	--	--	Drinking Water
--	150	--	--	Drinking Water
--	500	--	--	Drinking Water
5.8 E-19	698	Tritium	100%	Drinking Water
--	1,000	--	--	Drinking Water
216-A-10 Crib				
--	0	--	--	Drinking Water
--	30	--	--	Drinking Water
--	150	--	--	Drinking Water
--	1,000	--	--	Drinking Water
2,100	1,193	Iodine-129	99.9%	Drinking Water
2,000	1,250	Iodine-129	99.9%	Drinking Water
216-A-19 Trench				
No breakthrough to groundwater				
216-A-36B Crib				
--	0	--	--	Drinking Water
--	30	--	--	Drinking Water
--	150	--	--	Drinking Water
--	1,000	--	--	Drinking Water
15.3	1,025	Technetium-99	100%	Drinking Water
5.7	1,100	Technetium-99	100%	Drinking Water
216-A-37-1 Crib				
--	0	--	--	Drinking Water
--	30	--	--	Drinking Water
--	150	--	--	Drinking Water
3.9 E-04	168	Tritium	100%	Drinking Water
1.8 E-12	500	Tritium	100%	Drinking Water
5.3 E-25	1,000	Tritium	100%	Drinking Water
216-B-12 Crib				
--	0	--	--	Drinking Water
--	30	--	--	Drinking Water
--	150	--	--	Drinking Water
--	500	--	--	Drinking Water
2.8 E-14	526	Tritium	100%	Drinking Water
6.0 E-27	1,000	Tritium	100%	Drinking Water
216-S-7 Crib				
--	0	--	--	Drinking Water
4.6	30	Tritium	100%	Drinking Water
--	150	--	--	Drinking Water
--	500	--	--	Drinking Water
--	1,000	--	--	Drinking Water
2.1	1,240	Technetium-99	100%	Drinking Water

* Based on 730 L/yr drinking water ingestion rate.

RESRAD = RESidual RADioactivity, ANL 2002, *RESRAD for Windows*, Version 6.21.

Table D-16. RESRAD Risk Results for Groundwater Protection.

Total Risk*	Time (years)	Primary Radionuclide	Percentage of Total Risk	Primary Pathway
207-A South Retention Basin				
--	0	--	--	Drinking Water
--	30	--	--	Drinking Water
--	150	--	--	Drinking Water
--	500	--	--	Drinking Water
4.0 E-24	698	Tritium	100%	Drinking Water
--	1,000	--	--	Drinking Water
216-A-10 Crib				
--	0	--	--	Drinking Water
--	30	--	--	Drinking Water
--	150	--	--	Drinking Water
--	1,000	--	--	Drinking Water
3.0 E-02	1,193	Iodine-129	99.9%	Drinking Water
3.0 E-02	1,250	Iodine-129	99.9%	Drinking Water
216-A-19 Trench				
No breakthrough to groundwater				
216-A-36B Crib				
--	0	--	--	Drinking Water
--	30	--	--	Drinking Water
--	150	--	--	Drinking Water
--	1,000	--	--	Drinking Water
6.0 E-04	1,025	Technetium-99	100%	Drinking Water
2.0 E-04	1,100	Technetium-99	100%	Drinking Water
216-A-37-1 Crib				
--	0	--	--	Drinking Water
--	30	--	--	Drinking Water
--	150	--	--	Drinking Water
9.0 E-09	168	Tritium	100%	Drinking Water
4.0 E-17	500	Tritium	100%	Drinking Water
--	1,000	Tritium	100%	Drinking Water
216-B-12 Crib				
--	0	--	--	Drinking Water
--	30	--	--	Drinking Water
--	150	--	--	Drinking Water
--	500	--	--	Drinking Water
7.0 E-19	526	Tritium	100%	Drinking Water
--	1,000	Tritium	100%	Drinking Water
216-S-7 Crib				
--	0	--	--	Drinking Water
1.0 E-04	30	Tritium	100%	Drinking Water
--	150	--	--	Drinking Water
--	500	--	--	Drinking Water
--	1,000	--	--	Drinking Water
1.0 E-04	1,240	Technetium-99	100%	Drinking Water

* Based on 730 L/yr drinking water ingestion rate.
RESRAD = RESidual RADioactivity, ANL 2002, *RESRAD for Windows*, Version 6.21.

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APPENDIX D

ATTACHMENT A

200 AREAS REMEDIAL INVESTIGATION AIR-RISK SCREENING

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CONTENTS

FIGURE

TABLES

TERMS

COPC	contaminant of potential concern
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
EPC	exposure-point concentration
HEAST	*Health Effects Assessment Summary Tables* (EPA/540/R-97/036)
HHRA	Human-Health Risk Assessment
IRIS	*Integrated Risk Information System* database
OU	operable unit
PEF	particulate emission factor
RA	risk assessment
RBC	risk-based concentration
RI	remedial investigation
RME	reasonable maximum exposure
TIC	tentatively identified compound
VF	volatilization factor
VOC	volatile organic compound
WAC	*Washington Administrative Code*

APPENDIX D

ATTACHMENT A

200 AREAS REMEDIAL INVESTIGATION AIR-RISK SCREENING

DA1.0 HUMAN-HEALTH RISK ASSESSMENT

This section presents the human-health risk assessment (HHRA) for the 200-PW-2 and 200-PW-4 Operable Units (OU) representative waste sites. This HHRA contains the following components:

- **Human-Health Risk Assessment Guidance.** Lists the guidance documents used for the HHRA
- **Contaminants of Potential Concern for Human Health.** Identifies the contaminants considered to be most important to the evaluation of human-health risk
- **Human Exposure and Toxicity Assessment.** Identifies the pathways by which potential human exposures could occur; describes how they are evaluated; and evaluates the magnitude, frequency, and duration of these exposures. Identifies the sources of toxicity values used
- **Risk-Assessment Results.** Integrates information from the exposure and toxicity assessments to characterize the risks to human health from potential exposure to contaminants in environmental media
- **Identification of Major Uncertainties and Assumptions.** Summarizes the basic assumptions used in the risk assessment (RA), as well as limitations of data and methodology.

DA1.1 HUMAN-HEALTH GUIDANCE

The procedures used for the HHRA are consistent with those described in the following U.S. Department of Energy (DOE) and U.S. Environmental Protection Agency (EPA) guidance documents:

- *Risk Assessment Guidance for Superfund (RAGS), Volume I -- Human Health Evaluation Manual, (Part A) Interim Final,* OSWER 9285.7-01A (EPA/540/1-89/002)
- *Risk Assessment Guidance for Superfund, Vol. I, Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors, (Interim Final),* OSWER Directive 9285.6-03 (EPA 1991)
- *Exposure Factors Handbook Volume 1: General Factors* (EPA/600/P-95/002Fa)

- *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final* (EPA/540/R-99/005)
- *Proposed Guidelines for Carcinogen Risk Assessment* (EPA/600/P-92/003C)
- *Supplemental Guidance to RAGS: Calculating the Concentration Term*, OSWER Publication 9285.7-081 (EPA 1992).

DA1.2 SELECTION OF CONTAMINANTS OF POTENTIAL CONCERN

Contaminants of potential concern (COPC) are those contaminants that should be carried through the HHRA process. This component of the HHRA process summarizes those contaminants that were detected in environmental media during the remedial investigation (RI) and identifies the COPCs for environmental media that are accessible for human exposure. During the course of the HHRA, the COPCs are evaluated to identify and prioritize those contaminants that are estimated to pose an unacceptable risk and thus should be addressed by the feasibility study.

DA1.2.1 Criteria for Selection of Contaminants of Potential Concern for the Human-Health Risk Assessment

Per EPA, Washington State Department of Ecology, and DOE guidance documents, the factors considered in identifying COPCs for the study area are as follows:

- Identification of detected contaminants
- Frequency of detection
- Essential nutrients
- Background screening
- Availability of toxicity factors for use in calculating risk-based concentrations (RBC).

The COPCs were identified separately for shallow-zone soil samples from each exposure area. Evaluation of the RA data using these criteria is discussed in the following subsections.

DA1.2.2 Identification of Detected Contaminants

As a conservative measure, all chemicals that were detected at least once in any of the shallow-zone soil samples were carried to the next step in the COPC selection process. Chemicals that were not detected in any of the soil samples (i.e., zero percent frequency of detection) were not selected as COPCs.

DA1.2.3 Shallow Zone (Evaluation of Human-Health Risk Assessment)

The summary statistics for all nonradiological contaminants in shallow-zone soil samples are presented in DOE/RL-2004-25, *Remedial Investigation Report for the 200-PW-2 Uranium-Rich*

Process Waste Group and 200-PW-4 General Process Condensate Group Operable Units, Attachment A. Only those analytes detected in at least one sample were carried forward to the next step in the risk screening process.

DA1.2.4 Essential Nutrients

Essential nutrients are those constituents considered essential for human nutrition. Recommended daily allowances are developed for essential nutrients, to estimate safe and adequate daily dietary intakes (NAS 1989, *Recommended Dietary Allowances*). Because aluminum, calcium, iron, magnesium, potassium, and sodium are considered to be essential nutrients and have no available toxicity factors, they were excluded from further consideration as COPCs.

DA1.2.5 Background Screening

The next criterion for identifying a COPC is its presence at a concentration higher than naturally occurring levels. Sitewide soil-background levels have been established for most metals and conventional chemistry (e.g., sulfate, nitrate) at the Hanford Site. The statewide soil-background level was used as the background level for cadmium. However, sitewide and statewide soil-background levels are not available for antimony, boron, cyanide, hexavalent chromium, molybdenum, selenium, or thallium; if these metals were detected, they were carried forward into the RA. Because background criteria have not been developed for volatile organic compounds (VOC), polychlorinated biphenyls, or semivolatile organic compounds in soils at the Hanford Site, any constituent detected also was carried forward into the RA.

The maximum detected concentration of each metal or inorganic compound detected in shallow-zone soil was compared to the 90^{th} percentile background value. Summaries of metals and inorganic compounds compared to background values are provided in Tables DA-1 through DA-6. The results of the screening are summarized in Table DA-7 and are detailed in the following paragraphs:

- **207-A Retention Basin Soil Borings (Table DA-1)**
  - Concentration exceeds background: nitrate as N, arsenic, and silver
  - No background value available: nitrate as nitrate/nitrite as N.
- **216-A-10 Crib** (Table DA-2)
  - Concentration exceeds background: no detected metals or inorganic compounds exceeded the 90^{th} percentile background value
  - No background value available: nitrate as nitrate/nitrite as N, nitrite as N, antimony, and boron.

- **216-A-19 Trench** (Table DA-3)
  - Concentration exceeds background: fluoride, nitrate as N, phosphate, arsenic, vanadium, and uranium
  - No background value available: nitrate as nitrate/nitrite as N, boron, and thallium.
- **216-A-36B Crib** (Table DA-4)
  - Concentration exceeds background: silver
  - No background value available: nitrate as nitrate/nitrite as N.
- **216-A-37-1 Crib** (Table DA-5)
  - Concentration exceeds background: ammonia as N, nitrate as N, barium, and manganese
  - No background value available: nitrate as nitrate/nitrite as N, nitrite as N, boron, and thallium.
- **216-B-12 Crib** (Table DA-6)
  - Concentration exceeds background: nitrate as N, sulfate, and arsenic
  - No background value available: nitrate as nitrate/nitrite as N, antimony, and boron.

Using the screening criteria as applied to the shallow-zone soil results, the analytes listed above all were carried through to the next step of the screening assessment.

DA1.2.6 Availability of Toxicity Values

All of the available toxicity data for analytes detected is provided in Table DA-8. If a toxicity value was not available from a reliable source, the contaminant could not be included in the screening RA. Although total petroleum hydrocarbon was not carried forward into the RA, constituents (such as polycyclic aromatic hydrocarbons, benzene, toluene, ethylbenzene, and xylenes) that represent the greatest risk to human health are included if detected. The exclusion of constituents from this RA because of the lack of available toxicity data potentially could result in an underestimated risk at the site.

The primary source of toxicity values (i.e., cancer potency factors and oral reference doses) is the *Integrated Risk Information System* (IRIS) database (EPA 2003). If a toxicity value is not available from IRIS, the toxicity values published in EPA/540/R-97/036, *Health Effects Assessment Summary Tables, FY 1997 Update* (HEAST); the *Region 9 Preliminary Remediation Goals (PRG) 2002 Tables* (EPA 2002a); or the *EPA Region 3 Risk-Based Concentration (RBC) 2002 Tables* (EPA 2002b), were used.

Toxicity values used to calculate the soil, air, and groundwater RBCs are presented in Table DA-8 and were obtained from the following sources:

- IRIS, a database prepared and maintained by the EPA and available through the EPA National Center for Environmental Assessment. IRIS is an electronic database containing health risk and EPA regulatory information on specific chemicals (EPA 2003)
- HEAST, provided by the EPA Office of Emergency and Remedial Response, is a compilation of toxicity values published in various health-effects documents issued by the EPA (EPA/540/R-97/036)
- *Region 9 Preliminary Remediation Goals (PRG) 2002 Tables* (EPA 2002a).
- *EPA Region 3 Risk Based Concentration (RBC) Tables* (EPA 2002b).

DA1.2.7 Tentatively Identified Compounds

Section 4.3.2.1 of the 200-PW-2 and 200-PW-4 OU RI (DOE 2004-25) discusses numerous organic tentatively identified compounds (TIC) the logic for removal from further consideration. Appendix A, Chapter 4.0, of DOE/RL-2004-25 discusses removal of two TICs: 2-ethyl-1-hexanol and ethyl acetate. Both 2-ethyl-1-hexanol and ethyl acetate were excluded from the screening RA.

DA1.3 COMPUTATION OF EXPOSURE-POINT CONCENTRATIONS

The exposure-point concentrations (EPC) are estimated contaminant concentrations that a receptor may contact and are specific to each exposure medium (i.e., shallow- and deep-zone soils). For the direct-contact exposure routes, EPCs are represented by concentrations directly measured in soil. For the inhalation route, modeling was performed to estimate constituent concentrations in the air from particulate or vapor emissions from the soil.

DA1.3.1 Direct-Contact Exposure-Point Concentrations

As a conservative estimate, and because of the small number of samples collected, the maximum detected concentration was used for the EPC for both shallow-soil and ambient-air evaluations.

DA1.3.2 Ambient-Air Exposure-Point Concentrations

Air concentrations were estimated by modeling particulate or vapor emissions from soil. Air concentrations from vapor emissions were estimated using a volatilization factor (VF) for those constituents that are considered volatile. Volatile constituents considered for the inhalation pathway are operationally defined as those constituents with a Henry's law constant greater than 10^{-5} atm-m^3/mole and a molecular weight of less than 200 g/mole (EPA 2002a). Air concentrations from fugitive dust emissions were estimated using a particulate emissions factor (PEF) for those constituents that are not volatile. Equation DA-1 was used to estimate air concentrations from volatile or particulate emissions for the COPCs identified in Section DA1.4.

Equation DA-1: Calculated Air Concentration

$$Air\ Concentration = C_s \times \left(\frac{1}{PEF} or \frac{1}{VF} \right),$$

where:

C_s = soil concentration (mg/kg).

PEF = particulate emissions factor (1.32×10^9 m^3/kg).

VF = volatilization factor (chemical-specific) (m^3/kg).

Soil-saturation concentrations (C_{sat}) were calculated using Equation DA-2 (Section DA4.3.3.3). Furthermore, the VFs for VOCs detected in shallow-zone soil were calculated using Equation DA-3 (Section DA1.3.4). The PEF used to estimate fugitive dust emissions for nonvolatile compounds was obtained using Equation DA-4 (Section DA1.3.5). Site-specific data used in these calculations are provided in Table DA-9, and chemical-specific data for detected analytes meeting the volatility criteria listed above are provided in Table DA-10. Per EPA guidance, the saturated-soil concentration (Equation DA-2) was calculated and compared against the maximum detected soil concentration. For all of the analytes listed in Table DA-10, C_{sat} was less than the maximum detected soil concentration.

DA1.3.3 Soil-Saturation Concentration

Equation DA-2: Derivation of the Soil-Saturation Limit

$$C_{sat} = \frac{S}{\rho_b}(K_d \rho_b + \Theta_w + H' \Theta_a)$$

where:

Parameter	Definition (Units)	Default
C_{sat}	Soil saturation Concentration (mg/kg)	--
S	Solubility in water (mg/L-water)	Chemical-specific
ρ_b	Dry soil bulk density (kg/L)	Site-specific
n	Total soil porosity (L_{pore}/L_{soil})	Site-specific 1 - (ρ_b/ρ_s)
ρ_s	Soil particle density (kg/L)	Site-specific
K_d	Soil-water partition coefficient (L/kg)	K_{oc} x f_{oc} (chemical-specific)

Parameter	Definition (Units)	Default
k_{oc}	Soil organic carbon/water partition coefficient (L/kg)	Chemical-specific
f_{oc}	Fraction organic carbon content of soil (g/g)	Site-specific
θ_w	Water-filled soil porosity (L_{water}/L_{soil})	Site-specific
θ_a	Air-filled soil porosity (L_{air}/L_{soil})	Site-specific or n-Θ_w
H	Henry's law constant (atm-m^3/mol)	Chemical-specific
H'	Dimensionless Henry's law constant	H x 41, where 41 is a units conversion factor

DA1.3.4 Soil-to-Air Volatilization Factor

Equation DA-3: Derivation of the Volatilization Factor

$$VF_s(m^3/kg) = (Q/C) \, x \, \frac{(3.14 \, x \, D_A \, x \, T)^{1/2}}{(2 \, x \, \rho_b \, x \, D_A)} \, x \, 10^4 (m^2/cm^2)$$

$$D_A = \frac{[(\Theta_a^{10/3} D_i H' + \Theta_w^{10/3} D_w)/n^2]}{\rho_b K_d + \Theta_w + \Theta_a H'}$$

where:

Parameter	Definition (Units)	Default
VF_s	Volatilization factor (m^3/kg)	--
D_A	Apparent diffusivity (cm^2/s)	--
Q/C	Inverse of the mean conc. at the center of a 0.5-acre square source (g/m^2-s per kg/m^3)	Site-specific
T	Exposure interval (s)	9.5×10^8
ρ_b	Dry soil bulk density (g/cm^3)	Site-specific
θ_a	Air filled soil porosity (L_{air}/L_{soil})	Site-specific or n-Θ_w
n	Total soil porosity (L_{pore}/L_{soil})	Site-specific 1 - (ρ_b/ρ_s)
θ_w	Water-filled soil porosity (L_{water}/L_{soil})	Site-specific
ρ_s	Soil particle density (g/cm^3)	Site-specific
D_i	Diffusivity in air (cm^2/s)	Chemical-specific
H	Henry's law constant (atm-m^3/mol)	Chemical-specific
H'	Dimensionless Henry's law constant	Calculated from H by multiplying by 41 (EPA 1991a)

Parameter	Definition (Units)	Default
D_w	Diffusivity in water (cm^2/s)	Chemical-specific
K_d	Soil-water partition coefficient (cm^3/g) = $K_{oc}f_{oc}$	Chemical-specific
k_{oc}	Soil organic carbon-water partition coefficient (cm^3/g)	Chemical-specific
f_{oc}	Fraction organic carbon in soil (g/g)	Site-specific

DA1.3.5 Soil-to-Air Particulate-Emission Factor

Equation DA-4: Derivation of the Particulate Emission Factor

$$PEF(m^3/kg) = Q/C\,x\,\frac{3600s/h}{0.036\,x\,(1-V)\,x\,(U_m/U_t)^3\,x\,F(x)}$$

where:

Parameter	Definition (Units)	Default
PEF_s	Particulate emission factor (m^3/kg)	Site-specific
Q/C	Inverse of the mean conc. at the center of a 0.5-acre square source (g/m^2-s per kg/m^3)	73.44 (Salem, Oregon)
V	Fraction of vegetative cover (unitless)	Site-specific or 0.5
U_m	Mean annual windspeed (m/s)	Site-specific or 4.69
U_t	Equivalent threshold value of windspeed at 7 m (m/s)	Site-specific or 11.32
F(x)	Function dependent on U_m/U_t derived using Cowherd (1985) (unitless)	Site-specific or 0.194

DA1.4 SUMMARY OF CONTAMINANTS OF POTENTIAL CONCERN

Using the background screening results provided in Tables DA-1 through DA-6 and the toxicity data in Table DA-8, the shallow-zone-soil air COPCs are provided in Tables DA-11 through DA-16. The COPCs are listed in the following paragraphs by OU.

- **207-A Retention Basin Soil Borings** (Table DA-16)
  - COPCs: 2-(2,4,5-trichlorophenoxy)-propionic acid, 2,4-dichlorophenoxyacetic acid, arsenic, butylbenzenephthalate, diethylphthalate, chloroform, and methylene chloride
- **216-A-10 Crib** (Table DA-12)
  - COPCs: boron and beta-BHC.

- **216-A-19 Trench** (Table DA-13)
  - COPCs: arsenic, boron, and bis-(2-ethylhexyl)-phthalate.
- **216-A-36B Crib** (Table DA-14)
  - COPCs: diethylphthalate.
- **216-A-37-1 Crib** (Table DA-15)
  - COPCs: barium, boron, manganese, and bis-(2-ethylhexyl)-phthalate.
  - Although ammonia as N was present above background levels and toxicity data are available, it is not regulated under WAC 173-340, "Model Toxics Control Act -- Cleanup," so it was not selected as a COPC.
- **216-B-12 Crib** (Table DA-16)
  - COPCs: arsenic, boron, bis-(2-ethylhexyl)-phthalate, and di-n-butylphthalate.

DA1.5 HUMAN-EXPOSURE ASSESSMENT

The exposure-assessment component of the HHRA identifies the populations that may be exposed; the routes by which these individuals may become exposed; and the magnitude, frequency, and duration of potential exposures. The human-exposure assessment includes the following components:

- Development of exposure assumptions for potentially complete exposure pathways
- Calculation of chemical intake for COPCs
- Source of toxicity values.

DA1.5.1 Human-Exposure Assumptions

The estimation of exposure requires numerous assumptions to describe potential exposure scenarios. Upper-bound exposure assumptions are used to estimate reasonable maximum exposure (RME) conditions to provide a bounding estimate on exposure. The exposure assumptions and methodology used to develop soil RBCs for nonradiological constituents, and the assumptions and methodology used to calculate risk and dose estimates for radiological constituents, are described in the following sections.

DA1.5.2 Nonradiological Constituents

The exposure assumptions used to develop risk-based soil-screening concentrations for soil for the ambient-air exposure pathway for nonradiological constituents are listed in Table DA-17. The scenarios evaluated were selected based on the conceptual exposure model provided in Figure DA-1 and are consistent with the reasonably anticipated future land use.

DA1.5.3 Industrial Land-Use Scenario

Exposure estimates for current and future industrial workers are based on the assumption that a 70-kg adult would contact surface soil 146 days per year during a 20-year period. For the inhalation pathway, an inhalation rate of 20 m^3/day was assumed.

DA1.5.4 Equations for Ambient-Air Risk-Based Concentrations

Ambient air RBCs were calculated for all COPCs identified in Tables DA-11 through DA-16. The following equations were used to calculate the ambient air RBCs under the industrial land-use exposure scenario for carcinogens and noncarcinogens. The exposure assumptions used to calculate the RBCs for each exposure scenario are listed in Table DA-17.

Carcinogens. The following equation was used to calculate the industrial ambient-air RBCs for carcinogenic chemicals:

$$Air\ RBC(mg/m^3) = \frac{TR \times BWc \times ATC}{CPF_i \times INH \times ABS_{INH} \times EF \times ED}.$$

Noncarcinogens. The following equation was used to calculate the industrial ambient-air RBCs for noncarcinogenic chemicals:

$$Air\ RBC(mg/m^3) = \frac{THQ \times BW_{nc} \times ATN \times RfDi}{EF \times ED \times INH \times ABS_{inh}}.$$

These equations are from WAC 173-340-750, "Cleanup Standards to Protect Air Quality," and the calculated industrial ambient-air RBCs are consistent with the latest tables in Ecology 94-145, *Cleanup Levels and Risk Calculations under the Model Toxics Control Act Cleanup Regulation; CLARC, Version 3.1.*

DA1.6 RISK-ASSESSMENT RESULTS FOR NONRADIOLOGICAL CONTAMINANTS

All nonradiological COPCs identified in Section 1.4 were compared to their respective RBCs for each of the three applicable exposure media.

All RBCs developed for this site were based on chronic or carcinogenic threats. The maximum soil concentration was compared with its respective RBC. For the purposes of this document, contaminant concentrations were compared to risk-based concentrations developed under *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* guidance (EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I -- Human Health Evaluation Manual (Part B. Development of Risk-Based Preliminary Remediation Goals), Interim*, Publication 9285.7-01B) using the excess lifetime cancer risk range of 10^{-4} to 10^{-6} and using a hazard quotient of 1.0 with an industrial land-use scenario. Because the waste sites in these OUs are in the core zone, risk-based concentrations for shallow-zone soils used for screening correspond to a 10^{-5} risk level. Because groundwater protection RBCs are designed to protect potential future off-site users of groundwater, the screening calculations for the groundwater protection RBCs were determined using a target risk of 10^{-6}. These target risks are consistent with WAC 173-340.

The hazard quotient can be calculated by dividing the concentration term by its noncancer RBC. As described above, a ratio greater than 1 suggests a potential for adverse health effects.

Carcinogenic risk is expressed as a probability of developing cancer as a result of lifetime exposure. For a given chemical and exposure route, excess lifetime cancer risk can be back-calculated by dividing the concentration term by its cancer RBC, then multiplying by 10^{-5} (for industrial-soil RBCs) to estimate chemical-specific risk. An excess lifetime cancer risk that exceeds the target risk threshold of 1×10^{-5} indicates that, as a plausible upper-bound, an individual has a 1-in-100,000 chance of developing cancer as a result of site-related exposure to a carcinogen during a 75-year lifetime, under the specific exposure conditions at the site. The acceptable risk level for industrial land use is 1×10^{-5}. Generally, the EPA considers action to be warranted at a site when the cancer risks exceed 1×10^{-4}, based on an RME scenario. Generally, action is not required for risks falling within 1×10^{-4} to 1×10^{-6}. A hazard index greater than one indicates that some potential for adverse noncancer health effects is associated with exposure to the contaminants of concern (EPA 1991). Generally, action is not required for a hazard index of less than one.

DA1.6.1 Results of Comparison to Ambient-Air Risk-Based Concentrations

Table DA-18 provides the results of the comparison of maximum soil concentrations to ambient-air RBCs. All of the calculated maximum air concentrations were below their respective ambient-air RBCs.

DA1.7 UNCERTAINTY ANALYSIS

Uncertainties associated with sampling and analysis include the inherent variability (standard error) in the analysis, representativeness of the samples, sampling errors, and heterogeneity of the sample matrix. While the quality assurance/quality control program used in conducting the sampling and analysis serves to reduce errors, it cannot eliminate all errors associated with sampling and analysis.

DA1.7.1 Uncertainty Associated with Exposure Assessment

Future soil EPCs were assumed to be equal to existing soil concentrations. This assumption does not account for fate and transport processes likely to occur in the future; risk estimates are likely to be overestimated for future exposure scenarios.

The estimation of exposure requires many assumptions to describe potential exposure situations. There are uncertainties regarding the likelihood of exposure, the frequency of contact with contaminated media, the concentration of contaminants at exposure points, and the time period of exposure. These tend to simplify and approximate actual site conditions. In general, these assumptions are intended to be conservative and to yield an overestimate of the true risk or hazard.

The exposure assumptions conservatively estimate the current and future industrial land-use scenario risks. A worker is unlikely to remain at the same place of employment for 146 days a year during a 25-year exposure duration. The default exposure assumptions for the industrial land-use scenarios likely overestimate risk at the Hanford Site.

DA1.7.2 Uncertainty Associated with Toxicity Assessment

The toxicological database also was a source of uncertainty. EPA has outlined some of the sources of uncertainty in EPA/540/1-89/002. These sources may include or result from the extrapolation from high to low doses and from animals to humans; the species, gender, age, and strain differences in a toxin's uptake, metabolism, organ distribution, and target site susceptibility; and the human population's variability with respect to diet, environment, activity patterns, and cultural factors.

Exclusion of constituents without toxicity values from this RA potentially could underestimate risk at the site. Conversely, inclusion of metals without background values (chromium (VI)) or with background values significantly greater than the RBC (e.g., arsenic) could result in overestimation of risk, caused by site contaminants to which the public is routinely exposed because of background soil concentrations.

DA1.7.3 Uncertainty Associated with Risk Characterization

In the risk characterization, the assumption was made that the total risk of developing cancer from exposure to the Hanford Site is the sum of the risk attributed to each individual contaminant. Likewise, the potential for the development of noncancer adverse effects is the sum of the hazard quotients estimated for exposure to each individual contaminant. This approach, in accordance with EPA guidance, did not account for the possibility that constituents act synergistically or antagonistically.

Figure DA-1. Conceptual Exposure Model.

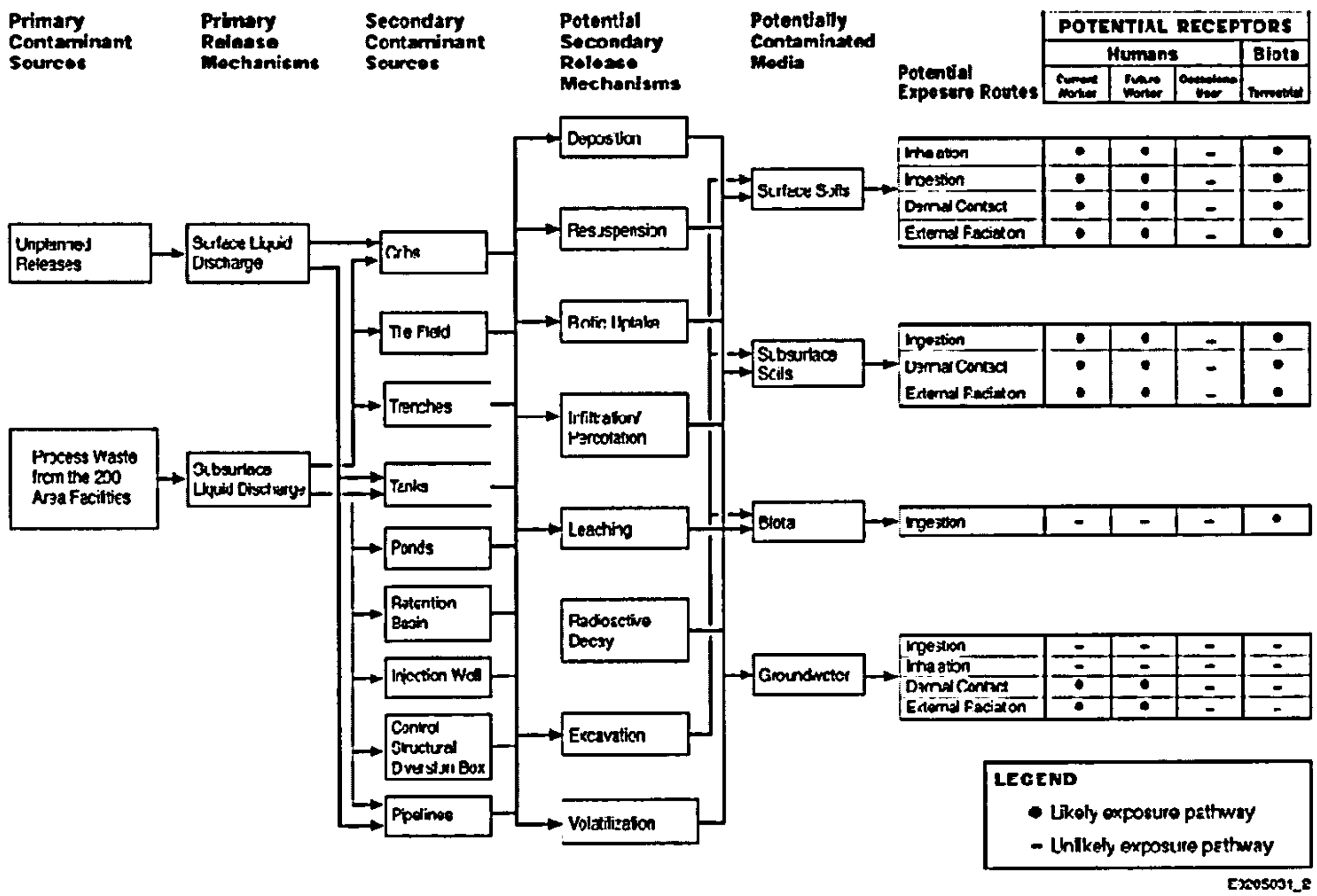

Table DA-7. Summary of Detected Metals and Inorganic Compounds that Exceed the Background Screening or for Which No Background Value is Available for the Human-Health Ambient-Air Risk Assessment.

Constituent	207-A Retention Basin Soil Borings	216-A-10 Crib	216-A-19 Trench	216-A-36B Crib	216-A-37-1 Crib	216-B-12 Crib
Ammonia as N					X	
Fluoride			X			
Nitrate and nitrate/nitrite as N	O	O	O	O	O	O
Nitrate as N	X		X		X	X
Nitrite as N		O			O	
Phosphate			X			
Sulfate						X
Antimony		O				O
Arsenic	X		X			X
Barium					X	
Boron		O	O		O	O
Manganese					X	
Silver	X			X		
Thallium			O		O	
Uranium (mg/kg)			X			
Vanadium			X			

O = detected, but no background values available.
X = exceeds background value.

Table DA-8. Summary of Toxicity Values Used to Calculate Risk-Based Concentrations.

Constituent Class	Constituent	Chemical Abstracts Service Number	Inhalation Cancer Potency Factor $(mg/kg\text{-}day)^{-1}$	Source	Inhalation Reference Dose (mg/kg-day)	Source
CONV	Ammonia as N	7664-41-7	--	--	0.028571429	i
HERB	2-(2,4,5-trichlorophenoxy)propionic acid	93-72-1	--	--	0.008	r
HERB	2,4-dichlorophenoxyacetic acid	94-75-7	--	--	0.01	r
METAL	Aluminum	7429-90-5	--	--	0.0014285	p
METAL	Arsenic	7440-38-2	15.05	i	15	i
METAL	Barium	7440-39-3	--	--	0.0001	i
METAL	Beryllium	7440-41-7	8.4	i	0.00000571	i
METAL	Boron	7440-42-8	--	--	0.005714286	h
METAL	Cadmium	7440-43-9	6.3	i	0.000057	n
METAL	Chromium (Total)	7440-47-3	42	i	--	--
METAL	Cobalt	7440-48-4	9.8	p	5.71429E-06	p
METAL	Manganese	7439-96-5	--	--	0.000014	i
PEST	Beta-BHC (B-BHC)	319-85-7	1.8	i	--	--
SVOA	Bis(2-ethylhexyl)phthalate	117-81-7	0.014	r	0.02	r
SVOA	Butylbenzylphthalate	85-68-7	--	--	0.2	r
SVOA	Diethylphthalate	84-66-2	--	--	0.8	r
SVOA	Di-n-butylphthalate	84-74-2	--	--	0.1	r
VOA	Chloroform	67-66-3	0.0805	i	0.012857143	p
VOA	Methylene chloride	75-09-2	0.001645	i	0.857142857	h

-- = not applicable.
h = EPA/540/R-97/036, *Health Effects Assessment Summary Tables, FY 1997 Update.*
i = EPA, 2003, *Integrated Risk Information System* (IRIS) database.
n = EPA, 2002, *Region 9 Preliminary Remediation Goals (PRG) 2002 Tables.*
p = provisional peer-reviewed toxicity value.
r = route extrapolation: a method that translates the oral toxicity factor into an inhalation toxicity factor.
CONV = conventional parameter.
SVOA = semivolatile organic analyte.
VOA = volatile organic analyte

Table DA-9. Site-Specific Air Exposure-Point Concentration Calculation Input Parameters.

Parameter	Description	Value	Source
Q/C	Inverse of the mean concentration at the center of a 0.5-acre-square source (g/m2-s per kg/m^3)	73.44	B
T	Exposure interval (s)	9.5 E+08	B
ρ_b	Dry-soil bulk density (g/cm^3)	1.5	A
θ_a	Air-filled soil porosity (Lair/Lsoil)	0.13	A
n	Total soil porosity (L_{pore}/L_{soil})	0.43	B
θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.3	A
ρ_s	Soil particle density (g/cm3)	2.65	B
foc	Fraction of organic carbon in soil (g/g)	0.001	A
V	Fraction of vegetative cover (unitless)	0.5	B
Um	Mean annual windspeed (m/s)	4.69	B
Ut	Equivalent threshold value of windspeed at 7 m (m/s)	11.32	B
F(x)	Function dependent on U_m/U_t derived using EPA/600/8-85/002 (unitless)	0.194	B

A = WAC 173-340-750(4), "Cleanup Standards to Protect Air Quality," "Method C Air Cleanup Levels." EPC = exposure-point concentration.
B = EPA/540/R-95/128, *Soil Screening Guidance: Technical Background Document.*

Table DA-10. Chemical-Specific Input Parameters for Detected Analytes with Molecular Weight Less Than 200 g/mole and Henry's Law Constant Greater Than 4.1×10^{4}.

Constituent Class	Constituent	Chemical Abstracts Service	Molecular Weight (g/mole)	Henry's Law Constant (unitless)	Diffusivity in Air (cm^2/s)	Diffusivity in Water (cm^2/s)	Organic Carbon Partition Coefficient (L/kg)	Soil-Water Partition Coefficient (cm^3/g)	Water Solubility (mg/L)
SVOA	2-Methylnapthalene	91-57-6	142.2	2.12 E-02	4.80 E-02	7.84 E-06	2.98 E+03	2.98 E+00	2.46 E+01
SVOA/VOA	Naphthalene	91-20-3	128.16	1.98 E-02	5.90 E-02	7.50 E-06	1.19 E+03	7.15 E+00	3.10 E+01
VOA	Acetone	67-64-1	58.08	1.59 E-03	1.24 E-01	1.14 E-05	5.75 E-01	3.45 E-03	1.00 E+06
VOA	Chloroform	67-66-3	119.38	1.50 E-01	1.04 E-01	1.00 E-05	5.30 E+01	3.18 E-01	7.92 E+03
VOA	Ethylbenzene	100-41-4	106.17	3.23 E-01	7.50 E-02	7.80 E-06	2.04 E+02	1.22 E+00	1.69 E+02
VOA	Methylene chloride	75-09-2	84.93	8.98 E-02	1.01 E-01	1.17 E-05	1.00 E+01	1.00 E-02	1.32 E+04
VOA	n-Butylbenzene	104-51-8	134.22	5.37 E-01	7.50 E-02	7.80 E-06	2.83 E+03	1.70 E+01	1.38 E+01
VOA	Xylenes (total)	1330-20-7	106.17	3.01 E-01	7.00 E-02	7.80 E-06	1.96 E+02	1.18 E+00	1.61 E+02

SVOA = semivolatile organic analyte. VOA = volatile organic analyte.

Table DA-17. Summary of Exposure Assumptions for Industrial Soil Ambient-Air Risk-Based Concentrations.

Parameter	Symbol	Units	Industrial Land Use [a]
Target risk	TR	unitless	1.0 E-05
Target hazard quotient	THQ	unitless	1
Oral reference dose	RfDo	mg/kg-day	chemical specific
Oral cancer potency factor	CPFo	kg-day/mg	chemical specific
Inhalation reference dose	CPFi	mg/kg-day	chemical specific
Inhalation cancer potency factor	RfDi	kg-day/mg	chemical specific
Unit conversion factor - air	UCFa	µg/mg	1.0 E+03
Body weight –adult	BWa	kg	70
Carcinogenic averaging time	ATC	years	75
Noncarcinogenic averaging time	ATN	years	20
Exposure frequency	EF	unitless	0.4
Exposure duration	ED	years	20
Incidental soil ingestion rate	SIR	mg/day	50
Inhalation rate – carcinogens	INHc	m^3/day	20
Inhalation rate – noncarcinogens	INHnc	m^3/day	20
Gastrointestinal absorption factor	ABSgi	unitless	1
Inhalation absorption fraction	ABSinh	unitless	1

[a] WAC 173-340-750 (4), Cleanup Standards to Protect Air Quality," "Method C Air Cleanup Levels."

Table DA-18. Comparison of Maximum Shallow-Zone Soil Concentrations to Industrial Ambient-Air Protection Risk-Based Concentrations. (2 Pages)

Location	Constituent	Maximum Detected Concen-tration (µg/kg)	C_{sat} (µg/kg)	VF (m^3/kg)	PEF (m^3/kg)	PEF or VF (m^3/kg)	1/PEF or 1/VF (kg/m^3)	Maximum Air Concen-tration (µg/m^3)	WAC 173-340-750 Ambient-Air RBC (µg/m^3)	Maximum Air Concen-tration Greater than Air RBC?
207-A Retention Basin Soil Borings	2-(2,4,5-trichlorophenoxy) propionic acid	3.30 E+00	--	--	1.06 E+09	1.06 E+09	9.39 E-10	3.10 E-09	2.80 E+01	No
207-A Retention Basin Soil Borings	2,4-dichlorophenoxyacetic acid	7.10 E+00	--	--	1.06 E+09	1.06 E+09	9.39 E-10	6.67 E-09	3.50 E+01	No
207-A Retention Basin Soil Borings	Arsenic	9.98 E+03	--	--	1.06 E+09	1.06 E+09	9.39 E-10	9.37 E-06	8.72 E-03	No
207-A Retention Basin Soil Borings	Butylbenzylphthalate	1.10 E+02	2.4 1E+05	--	1.06 E+09	1.06 E+09	9.39 E-10	1.03 E-07	7.00 E+02	No
207-A Retention Basin Soil Borings	Diethylphthalate	3.20 E+02	--	--	1.06 E+09	1.06 E+09	9.39 E-10	3.01 E-07	2.80 E+03	No
207-A Retention Basin Soil Borings	Chloroform	5.00 E+00	4.21 E+06	1.22 E+04	1.06 E+09	1.22 E+04	8.18 E-05	4.09 E-04	1.63 E+00	No
207-A Retention Basin Soil Borings	Methylene chloride	5.00 E+00	2.87 E+06	1.02 E+04	1.06 E+09	1.02 E+04	9.77 E-05	4.88 E-04	7.98 E+01	No
216-A-10 Crib	Boron	8.90 E+02	--	--	1.06 E+09	1.06 E+09	9.39 E-10	8.36 E-07	2.00 E+01	No
216-A-10 Crib	Beta-BHC (B-BHC)	7.00 E+00	--	--	1.06 E+09	1.06 E+09	9.39 E-10	6.58 E-09	7.29 E-02	No
216-A-19 Trench	Arsenic	7.00 E+03	--	--	1.06 E+09	1.06 E+09	9.39 E-10	6.58 E-06	8.72 E-03	No
216-A-19 Trench	Boron	3.89 E+04	--	--	1.06 E+09	1.06 E+09	9.39 E-10	3.66 E-05	2.00 E+01	No
216-A-19 Trench	Bis(2-ethylhexyl)phthalate	6.60 E+02	--	--	1.06 E+09	1.06 E+09	9.39 E-10	6.20 E-07	9.38 E+00	No
216-A-36B Crib	Diethylphthalate	2.80 E+02	--	--	1.06 E+09	1.06 E+09	9.39 E-10	2.63 E-07	2.80 E+03	No
216-A-37-1 Crib	Barium	1.65 E+05	--	--	1.06 E+09	1.06 E+09	9.39 E-10	1.55 E-04	2.45 E+02	No
216-A-37-1 Crib	Boron	5.10 E+02	--	--	1.06 E+09	1.06 E+09	9.39 E-10	4.79 E-07	2.00 E+01	No
216-A-37-1 Crib	Manganese	5.47 E+05	--	--	1.06 E+09	1.06 E+09	9.39 E-10	5.14 E-04	4.90 E-02	No
216-A-37-1 Crib	Bis(2-ethylhexyl)phthalate	2.10 E+01	--	--	1.06 E+09	1.06 E+09	9.39 E-10	1.97 E-08	9.38 E+00	No

Table DA-18. Comparison of Maximum Shallow-Zone Soil Concentrations to Industrial Ambient-Air Protection Risk-Based Concentrations. (2 Pages)

Location	Constituent	Maximum Detected Concentration (µg/kg)	C_{sat} (µg/kg)	VF (m^3/kg)	PEF (m^3/kg)	PEF or VF (m^3/kg)	1/PEF or 1/VF (kg/m^3)	Maximum Air Concentration (µg/m^3)	WAC 173-340-750 Ambient-Air RBC (µg/m^3)	Maximum Air Concentration Greater than Air RBC?
216-B-12 Crib	Arsenic	7.30 E+03	--	--	1.06 E+09	1.06 E+09	9.39 E-10	6.86 E-06	8.72 E-03	No
216-B-12 Crib	Boron	1.30 E+03	--	--	1.06 E+09	1.06 E+09	9.39 E-10	1.22 E-06	2.00 E+01	No
216-B-12 Crib	Bis(2-ethylhexyl)phthalate	1.80 E+01	--	--	1.06 E+09	1.06 E+09	9.39 E-10	1.69 E-08	9.38 E+00	No
216-B-12 Crib	Di-n-butylphthalate	7.70 E+01	--	--	1.06 E+09	1.06 E+09	9.39 E-10	7.23 E-08	3.50 E+02	No

WAC 173-340-750, "Cleanup Standards to Protect Air Quality."
PEF = particulate emission factor.
RBC = risk-based concentration.
VF = volatilization factor.

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APPENDIX D

ATTACHMENT B

INTRUDER ANALYSIS

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CONTENTS

FIGURE

TABLES

TERMS

COPC	contaminant of potential concern
DCF	dose conversion factor
EPC	exposure-point concentration
ILAW	immobilized low-activity waste
OU	operable unit
RESRAD	RESidual RADioactivity (dose model) (ANL 2002)
RI	remedial investigation
RI Report	*Remedial Investigation Report for the 200-PW-2 Uranium-Rich Process Waste Group and 200-PW-4 General Process Condensate Group Operable Units* (DOE/RL-2004-25)
Work Plan	*Uranium-Rich/General Process Condensate and Process Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan; Includes 200-PW-2 and 200-PW-4 Operable Units* (DOE/RL-2000-60)

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APPENDIX D

ATTACHMENT B

INTRUDER ANALYSIS

DB1.0 INTRODUCTION

The RESidual RADioactivity (RESRAD) computer program (ANL 2002, *RESRAD for Windows*, Version 6.21) was used to evaluate potential adverse health effects related to possible future human intrusion of and exposure to residual radionuclides in soil at the 216-B-10 Crib, 216-A-19 Trench, 216-A-10 Crib, 216-A-36B Crib, 207-A South Retention Basin, 216-A-37-1 Crib, and 216-S-7 Crib. Radiological contaminants of potential concern (COPC) were identified in DOE/RL-2004-25, *Remedial Investigation Report for the 200-PW-2 Uranium-Rich Process Waste Group and 200-PW-4 General Process Condensate Group Operable Units* (remedial investigation [RI] Report), based on detection status and comparison to background concentrations. The input parameter values for the RESRAD modeling, and the associated rationale and assumptions, are discussed in Chapter 2.0 of the RI Report. Chapter 3.0 of the RI Report describes the results of RESRAD modeling of potential health effects. Both radiological dose and cancer risk are assessed as health-effects endpoints. Chapter 4.0 of the RI Report provides an uncertainty analysis for the RESRAD modeling.

Three intruder scenarios are evaluated for the 200-PW-2 and 200-PW-4 Operable Units (OU). These scenarios are based on the framework documented in HAB 132, "Exposure Scenarios Task Force on the 200 Area," a letter from the Hanford Advisory Board, and are provided for informational purposes only. Inadvertent intruder scenarios are based on the possibility that an individual unwittingly (through human error or loss of knowledge concerning the location of contaminants) engages in an activity that results in contact with wastes left in place (10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste"). The reasonably anticipated future land use for the 200 Areas is continued industrial activities, based on DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, and the associated record of decision (64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)"). For locations within the industrial area, the U.S. Department of Energy dose rate limits for the protection of workers and the affected public will be in effect for as long as facility management operations continue.

After the cessation of operations, protection of human receptors will be based on U.S. Environmental Protection Agency guidance for protection of individuals receiving a reasonable maximum potential exposure. A target incremental cancer risk below or within a 10^{-4} to 10^{-6} risk range was identified. A direct-exposure dose rate of 15 mrem/yr above background was used as an operational guideline to achieve this goal.

After a period of 50 years, it is assumed that all operations will have ceased, and public entry to the site will be restricted for an additional 100 years by enforcement of institutional controls. It is presumed that after 150 years, an intruder could obtain access to the sites evaluated in this feasibility study.

The three intruder scenarios proposed for evaluation are as follows:

- Future Construction-Trench-Worker Intruder Scenario
- Future Well-Driller Intruder Scenario (drill cuttings)
- Future Rural-Residential Intruder Scenario (drill cuttings).

The future rural-residential scenario is considered to be the worst case scenario, because exposure time would be the greatest. The seven representative waste sites in the 200-PW-2 and 200-PW-4 OU were evaluated for an exposure time starting at 150 years in the future, when it is postulated that institutional controls may have failed. An evaluation of potential intruder doses after a 500-year control period also was conducted. The three intruder scenarios are summarized in the following subsections. Details and rationale for the specific modeling assumptions and parameter values are provided in Chapter DB2.0.

DB1.1 FUTURE CONSTRUCTION-TRENCH-WORKER INTRUDER SCENARIO

This scenario describes potential contact with contaminants by inadvertently excavating a utilities trench or other construction activity (including the excavation of a basement or building foundation) through a waste site. The worker at the trench construction site is assumed to be exposed 8 hours a day for 5 days. The dose to the worker is the sum of the contributions from inhaling resuspended dust, inadvertently ingesting soil, and incurring direct exposure at the center of a 200 m^2 (2,153 ft^2) area of contaminated soil for 40 hours.

DB1.2 FUTURE WELL-DRILLER INTRUDER SCENARIO

This scenario describes potential contact with contaminants associated with inadvertently drilling a well at a waste site. The drill cuttings (both uncontaminated and contaminated soil) are assumed to have been spread over the work area near the well. Based on the evaluations for DOE/ORP-2000-24, *Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version* (Immobilized Low-Activity Waste [ILAW] performance assessment) and BHI-00169, *Environmental Restoration Disposal Facility Performance Assessment*, the diameter of the well for this evaluation is assumed to be 0.3 m (1 ft). The area on which the driller spreads the cuttings is assumed to be 200 m^2 (2,153 ft^2).

The worker at the well-drilling site is assumed to be exposed 8 hours a day for 5 days. The dose to the worker is the sum of the contributions from inhaling resuspended dust, inadvertently ingesting soil, and incurring direct exposure at the center of a 200 m^2 (2,153-ft^2) area of contaminated soil for 40 hours.

DB1.3 FUTURE RURAL-RESIDENTIAL INTRUDER SCENARIO

This scenario is an extension of the well-driller scenario described in Section DB1.2. It describes potential contact with contaminants for a residential receptor who has planted a

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DB2.0 RESRAD MODELING ASSUMPTIONS AND INPUT PARAMETERS

RESRAD modeling was conducted for potential intrusion events occurring at 150 and 500 years from the present. The model simulations approximated these future events by defining an effectively static contaminated zone on the ground surface. The attributes of the contaminated zone related to each of the three intrusion scenarios are described in Sections DB2.1 (Contaminated-Zone Area and Thickness) and DB2.2 (Soil Concentrations). The soil concentrations used in the RESRAD modeling reflect present-day radionuclide concentrations measured during the RI, which then were subject to radioactive decay and ingrowth over the 150- and 500-year modeling periods.

An evaluation of potential radiological dose and cancer risk related to inadvertent intrusion was performed recently for DOE/RL-2004-24, *Feasibility Study for the 200-CW-5 (U Pond/Z Ditches Cooling Water Waste group), 200-CW-2 (S Pond and Ditches Cooling Water Waste Group), 200-CW-4 (T Pond and Ditches Cooling Water Waste Group), and 200-SC-1 (Steam Condensate Waste Group) Operable Units*, and DOE/RL-2003-23, *Focused Feasibility Study for the 200-UW-1 Operable Unit*. The assumptions related to the modeling of intruder impacts in these documents were reviewed and, where applicable, incorporated into this assessment to maintain programmatic consistency.

As described in the RI Report (DOE/RL-2004-25), an industrial-exposure scenario was used in the RI to evaluate potential surface exposure to radionuclides in soil. The specific parameter values and associated references for each RESRAD input parameter for industrial land use were provided in Table 4-13 of the RI (DOE/RL-2004-25). The following subsections discuss differences in RESRAD modeling for the intruder scenarios relative to the industrial scenario. Differences are related primarily to three types of RESRAD inputs: contaminated zone dimensions, soil concentrations, and occupancy. For the rural resident, changes also were made to RESRAD dietary parameters to accommodate a garden-produce exposure pathway. The only other changes relate to the contaminated-zone erosion rate and the depth of the soil-mixing layer for the well-driller and rural-resident scenarios. A description of RESRAD inputs that vary among construction-worker, well-driller, and rural-resident scenarios is provided below.

DB2.1 CONTAMINATED-ZONE AREA AND THICKNESS

For all three receptors associated with the intrusion scenario (construction trench worker, well driller, and rural resident), the region over which excavated materials are distributed is assumed to be circular with an area of 200 m^2. This area is described in DOE/RL-2004-24, Section E1.2 as "a size historically used in Hanford Site performance assessments." As described in Section DB1.3, a garden area of 200 m^2 was specified in the ILAW performance assessment (DOE/ORP-2000-24) to correspond to an area large enough to supply a significant portion of a person's vegetable and fruit diet, yet small enough to produce a higher (more conservative) estimation of dose.

The thickness of the contaminated zone in the construction-trench-worker scenario is calculated as the total volume of material excavated during the exposure period divided by the assumed exposure area of 200 m^2. The total excavated volume of material was calculated in DOE/RL-2003-23 as follows:

$$90 \text{ buckets/h} \times 0.255 \text{ m}^3\text{/bucket} \times 40 \text{ h} = 918 \text{ m}^3.$$

Based on the assumed exposure area, the resulting contaminated-zone depth in the construction-trench-worker scenario is:

$$918 \text{ m}^3 / 200 \text{ m}^2 = 4.6 \text{ m}.$$

The contaminated-zone thickness in the well-driller scenario is calculated as the total volume of well cuttings from a water well divided by the assumed exposure area of 200 m^2. The radius of a well is protectively assumed to be 0.15 m (DOE/RL-2004-24; DOE/RL-2003-23), and the depth is set equal to the depth to groundwater at each waste site. The total volume of well cuttings is then calculated as:

$$\text{well area } (\pi r^2) \times \text{well depth}.$$

The depth to groundwater at each waste site, the associated total volume of cuttings, and the resulting contaminated-zone depth for each waste site are shown in Table DB2-1. Depths to groundwater are based on borehole-log data, summarized in Table 5-1 of the RI Report (DOE/RL-2004-25).

Table DB2-1. Contaminated Zone Thickness for the Well-Driller Scenario.

Parameters	216-B-12 Crib	216-A-19 Trench	216-A-10 Crib	216-A-36B Crib	216-A-37-1 Crib	207-A South Retention Basin	216-S-7 Crib
Depth to Groundwater (m)	93	78	97	98	85	81	69
Volume of Cuttings (m^3)	6.6	5.5	6.9	6.9	6.0	5.7	4.9
Contaminated Zone Thickness (m)	3.3 E-02	2.8 E-02	3.4 E-02	3.5 E-02	3.0 E-02	2.9 E-02	2.4 E-02

The contaminated-zone thickness in the rural residential scenario is defined as 0.15 m. This thickness is associated with a nominal tilling depth related to gardening.

The contaminated-zone erosion rate for the construction-trench-worker scenario was set at the RESRAD default value of 1.0 E-03 m/yr, consistent with the industrial-scenario calculations described in the RI Report (DOE/RL-2004-25). For the well-driller scenario, however, the default erosion rate would remove the thin layer of well cuttings distributed on the ground surface within approximately 30 years. In the rural-resident scenario, where well cuttings are assumed to be mixed over a soil depth of 15 cm, the contaminated zone would be removed in 150 years. To develop protective estimates of potential dose and cancer risk for these scenarios, the contaminated-zone erosion rate was set to 0 m/yr in RESRAD.

DB2.2 SOIL CONCENTRATIONS

Soil exposure-point concentrations (EPC) for the construction-trench-worker scenario are calculated based on the shallow-zone EPCs used for the industrial-scenario assessment in the RI Report (DOE/RL-2004-25), modified by the specific dimensions of the contaminated zone described above. For the well-driller and rural-resident scenarios, EPCs are based on deep-zone EPCs used for the groundwater-protection analysis in the RI Report (DOE/RL-2004-25). The total volumes of excavated material generated by trenching and drilling also are modified by the relative quantities of contaminated and uncontaminated material in the excavation.

DB2.2.1 Construction-Trench-Worker Scenario Soil Concentrations

Maximum detected concentrations of radionuclides in the 0 m to 4.6 m (15 ft) shallow-zone soil layer of each waste site are used as the basis of the construction-trench-worker scenario calculations. The specific radionuclides and associated EPCs are those indicated in shading in the column labeled "Shallow-Zone Maximum Concentration" in Table 4-12 of the RI Report (DOE/RL-2004-25) and Table A4-1 of the 216-S-7 Crib RI, which is Appendix A of this feasibility study. These data also can be found in Table DB2-2.

Table DB2-2. Exposure-Point Concentrations for the Construction-Trench-Worker Scenario. (7 Pages)

Contaminant of Potential Concern	Background	Shallow Zone Maximum Concentration	"Cover" Exposure-Point Concentration	"No Cover" Exposure-Point Concentration
207-A-South Retention Basin				
Americium-241	NA	4.9 E-02	3.9 E-03	4.2 E-03
Antimony-125	NA	ND		
Carbon-14	NA	ND		
Cesium-134	NA	ND		
Cesium-137	Fallout	1.07	8.5 E-02	9.7 E-02
Cobalt-60	Fallout	ND		
Europium-152	NA	ND		
Europium-154	Fallout	ND		
Europium-155	Fallout	7.7 E-02	6.7 E-03	6.6 E-03
Iodine-129	NA	ND		
Neptunium-237	NA	ND		
Nickel-63	NA	ND		
Niobium-94	NA	3.2 E-02	2.5 E-03	2.7 E-03
Plutonium-238	Fallout	ND		
Plutonium-239/240	Fallout	1.2 E-02	9.5 E-04	1.0 E-03
Potassium-40	16.6	NLA		
Radium-226	8.15 E-01	0.859	6.8 E-02	7.3 E-02

Table DB2-2. Exposure-Point Concentrations for the Construction-Trench-Worker Scenario. (7 Pages)

Contaminant of Potential Concern	Background	Shallow Zone Maximum Concentration	"Cover" Exposure-Point Concentration	"No Cover" Exposure-Point Concentration
Radium-228	1.32	1.10		
Ruthenium-106	NA	ND		
Technetium-99	NA	ND		
Thorium-228[a]	1.32	7.37 E-01		
Thorium-230	1.10	1.26	0.10	0.11
Thorium-232	1.32	0.722		
Tin-126	NA	ND		
Strontium-90[b]	Fallout	1.40	0.11	0.12
Tritium	NA	16.6	1.31	1.41
Uranium-234	1.10	0.24		
Uranium-235	1.09 E-01	2.6 E-02		
Uranium-236	NA	NLA		
Uranium-238	1.06	0.27		
216-A-10 Crib				
Americium-241	NA	ND		
Antimony-125	NA	NA		
Carbon-14	NA	ND		
Cesium-134	NA	ND		
Cesium-137	Fallout	ND		
Cobalt-60	Fallout	ND		
Europium-152	NA	ND		
Europium-154	Fallout	ND		
Europium-155	Fallout	ND		
Iodine-129	NA	ND		
Neptunium-237	NA	4.3 E-02	1.7 E-02	--[c]
Nickel-63	NA	ND		
Niobium-94	NA	NA		
Plutonium-238	Fallout	ND		
Plutonium-239/240	Fallout	ND		
Potassium-40	16.6	18.7	7.87	--[c]
Radium-226	8.15 E-01	0.82	0.35	--[c]
Radium-228	1.32	ND		
Ruthenium-106	NA	NA		
Technetium-99	NA	ND		
Thorium-228 (a)	1.32	5.45 E-01		
Thorium-230	1.10	4.81 E-01		

Table DB2-2. Exposure-Point Concentrations for the Construction-Trench-Worker Scenario. (7 Pages)

Contaminant of Potential Concern	Background	Shallow Zone Maximum Concentration	"Cover" Exposure-Point Concentration	"No Cover" Exposure-Point Concentration
Thorium-232	1.32	4.81 E-01		
Tin-126	NA	ND		
Strontium-90[b]	Fallout	ND		
Tritium	NA	ND		
Uranium-234	1.10	0.39		
Uranium-235	1.09 E-01	ND		
Uranium-236	NA	NLA		
Uranium-238	1.06	3.38 E-01		
216-A-19 Trench				
Americium-241	NA	8.1 E-02	2.0 E-04	3.1 E-03
Antimony-125	NA	ND		
Carbon-14	NA	ND		
Cesium-134	NA	ND		
Cesium-137	Fallout	ND		
Cobalt-60	Fallout	ND		
Europium-152	NA	ND		
Europium-154	Fallout	ND		
Europium-155	Fallout	6.6 E-02	1.6 E-04	2.5 E-03
Iodine-129	NA	ND		
Neptunium-237	NA	ND		
Nickel-63	NA	17.6	4.4 E-02	0.67
Niobium-94	NA	ND		
Plutonium-238	Fallout	ND		
Plutonium-239/240	Fallout	0.18	4.5 E-04	6.9 E-03
Potassium-40	16.6	NLA		
Radium-226	8.15 E-01	4.39 E-01		
Radium-228	1.32	5.23 E-01		
Ruthenium-106	NA	ND		
Technetium-99	NA	ND		
Thorium-228[a]	1.32	0.47		
Thorium-230	1.10	5.07 E-01		
Thorium-232	1.32	4.29 E-01		
Tin-126	NA	ND		
Strontium-90[b]	Fallout	16.1	4.0 E-02	0.61
Tritium	NA	ND		
Uranium-234	1.10	6.0	1.5E-02	0.23

Table DB2-2. Exposure-Point Concentrations for the Construction-Trench-Worker Scenario. (7 Pages)

Contaminant of Potential Concern	Background	Shallow Zone Maximum Concentration	"Cover" Exposure-Point Concentration	"No Cover" Exposure-Point Concentration
Uranium-235	1.09 E-01	0.94	2.3 E-03	3.6 E-02
Uranium-236	NA	NLA		
Uranium-238	1.06	51.0	0.13	1.94
216-A-36B Crib				
Americium-241	NA	ND		
Antimony-125	NA	ND		
Carbon-14	NA	ND		
Cesium-134	NA	ND		
Cesium-137	Fallout	ND		
Cobalt-60	Fallout	ND		
Europium-152	NA	ND		
Europium-154	Fallout	ND		
Europium-155	Fallout	ND		
Iodine-129	NA	ND		
Neptunium-237	NA	ND		
Nickel-63	NA	ND		
Niobium-94	NA	ND		
Plutonium-238	Fallout	ND		
Plutonium-239/240	Fallout	ND		
Potassium-40	16.6	NA		
Radium-226	8.15 E-01	4.16 E-01		
Radium-228	1.32	6.52 E-01		
Ruthenium-106	NA	ND		
Technetium-99	NA	ND		
Thorium-228 (a)	1.32	ND		
Thorium-230	1.10	9.35 E-01		
Thorium-232	1.32	4.25 E-01		
Tin-126	NA	ND		
Strontium-90	Fallout	ND		
Tritium	NA	ND		
Uranium-234	1.10	0.15		
Uranium-235	1.09 E-01	1.8 E-02		
Uranium-236	NA	NA		
Uranium-238	1.06	0.17		
216-A-37-1 Crib				
Americium-241	NA	ND		

Table DB2-2. Exposure-Point Concentrations for the Construction-Trench-Worker Scenario. (7 Pages)

Contaminant of Potential Concern	Background	Shallow Zone Maximum Concentration	"Cover" Exposure-Point Concentration	"No Cover" Exposure-Point Concentration
Antimony-125	NA	ND		
Carbon-14	NA	ND		
Cesium-134	NA	ND		
Cesium-137	Fallout	1.13 E-01	5.4 E-02	1.13 E-01
Cobalt-60	Fallout	ND		
Europium-152	NA	ND		
Europium-154	Fallout	ND		
Europium-155	Fallout	ND		
Iodine-129	NA	ND		
Neptunium-237	NA	ND		
Nickel-63	NA	ND		
Niobium-94	NA	ND		
Plutonium-238	Fallout	ND		
Plutonium-239/240	Fallout	ND		
Potassium-40	16.6	NA		
Radium-226	8.15 E-01	4.06 E-01		
Radium-228	1.32	5.81 E-01		
Ruthenium-106	NA	ND		
Technetium-99	NA	ND		
Thorium-228[a]	1.32	5.72 E-01		
Thorium-230	1.10	ND		
Thorium-232	1.32	3.93 E-01		
Tin-126	NA	ND		
Strontium-90[b]	Fallout	1.70	0.81	1.70
Tritium	NA	134	64.1	134
Uranium-234	1.10	0.17		
Uranium-235	1.09 E-01	1.2 E-02		
Uranium-236	NA	NLA		
Uranium-238	1.06	0.18		
216-B-12 Crib				
Americium-241	NA	ND		
Antimony-125	NA	NA		
Carbon-14	NA	ND		
Cesium-134	NA	ND		
Cesium-137	Fallout	ND		
Cobalt-60	Fallout	ND		

Table DB2-2. Exposure-Point Concentrations for the Construction-Trench-Worker Scenario. (7 Pages)

Contaminant of Potential Concern	Background	Shallow Zone Maximum Concentration	"Cover" Exposure-Point Concentration	"No Cover" Exposure-Point Concentration
Europium-152	NA	ND		
Europium-154	Fallout	ND		
Europium-155	Fallout	ND		
Iodine-129	NA	ND		
Neptunium-237	NA	ND		
Nickel-63	NA	ND		
Niobium-94	NA	NA		
Plutonium-238	Fallout	ND		
Plutonium-239/240	Fallout	ND		
Potassium-40	16.6	14.2		
Radium-226	8.15 E-01	7.08 E-01		
Radium-228	1.32	ND		
Ruthenium-106	NA	NA		
Technetium-99	NA	ND		
Thorium-228[a]	1.32	5.84 E-01		
Thorium-230	1.10	1.19	0.29	--[c]
Thorium-232	1.32	7.16 E-01		
Tin-126	NA	7.42 E-01	0.18	--[c]
Strontium-90[b]	Fallout	ND		
Tritium	NA	8.28	2.03	--[c]
Uranium-234	1.10	6.05 E-01		
Uranium-235	1.09 E-01	NA		
Uranium-236	NA	NLA		
Uranium-238	1.06	6.28 E-01		
216-S-7 Crib				
Americium-241	NA	ND		
Antimony-125	NA	ND		
Carbon-14	NA	NLA		
Cesium-134	NA	3.7 E-02	5.7 E-03	
Cesium-137	Fallout	ND		
Cobalt-60	Fallout	ND		
Europium-152	NA	ND		
Europium-154	Fallout	ND		
Europium-155	Fallout	ND		
Iodine-129	NA	ND		
Neptunium-237	NA	ND		

Table DB2-2. Exposure-Point Concentrations for the Construction-Trench-Worker Scenario. (7 Pages)

Contaminant of Potential Concern	Background	Shallow Zone Maximum Concentration	"Cover" Exposure-Point Concentration	"No Cover" Exposure-Point Concentration
Nickel-63	NA	ND		
Niobium-94	NA	NLA		
Plutonium-238	Fallout	ND		
Plutonium-239/240	Fallout	ND		
Potassium-40	16.6	ND		
Radium-226	8.15 E-01	NLA		
Radium-228	1.32	6.49 E-01		
Ruthenium-106	NA	7.19 E-01		
Technetium-99	NA	ND		
Thorium-228[a]	1.32	7.49 E-01		
Thorium-230	1.10	5.27 E-01		
Thorium-232	1.32	7.72 E-01		
Tin-126	NA	NLA		
Strontium-90[b]	Fallout	ND		
Tritium	NA	184	28.1	
Uranium-234	1.10	0.16		
Uranium-235	1.09 E-01	ND		
Uranium-236	NA	NLA		
Uranium-238	1.06	0.17		

Data presented for radionuclides with half-life greater than 1 year.
[a]Background value based on secular equilibrium with thorium-232.
[b]Strontium-90 value based on analysis of total radioactive strontium.
[c]A "no-cover" alternative does not apply; see Section DB2.2.1.
Fallout = not applicable; fallout radionuclide.
NA = not applicable.
ND = nondetect.
NLA = no laboratory analysis.

The construction trench worker scenario is limited to a 4.6 m (15-ft) maximum depth and is conducted under two conditions. In the first condition, labeled the "cover" scenario, the site-specific depth of cover identified in Tables 2-1 and 2-2 of the Work Plan (DOE/RL-2000-60, *Uranium-Rich/General Process Condensate and Process Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan; Includes 200-PW-2 and 200-PW-4 Operable Units*) was accounted for when developing EPCs for the construction-trench worker. The cover material was assumed to be "clean," meaning that the cover was free of any radionuclides. The maximum detected concentration was assumed to be uniformly present across the entire waste site below the cover to a depth of 4.6 m (15 ft). In the second condition, labeled the "no-cover" scenario, the maximum detected concentration was assumed to be uniformly present from 0 m to 4.6 m (15 ft) below ground surface.

An exception to this general protocol for the construction-trench-worker scenario was made for the 216-A-10 Crib, 216-A-36B Crib, and 216-B-12 Crib. At these sites, the depth of cover is approximately 7.6 to 9.2 m (25 to 30 ft). Because the depth of cover is so great, removing the cover to create a "no cover" scenario was judged to be implausible at these sites.

An evaluation of construction-trench-worker exposure to radionuclides at the 216-A-10 Crib and the 216-B-12 Crib was still possible, however, because, unlike at the other sites evaluated in the RI Report, radionuclide COPCs were identified in samples of the cover material at these sites.[2] To ascertain whether unacceptable impacts may be associated with these COPCs, potential exposure to radionuclides in the existing cover was evaluated for the construction-trench worker at the 216-A-10 Crib and the 216-B-12 Crib. Because no radionuclide COPCs were found above background levels in the top 4.6 m (15 ft) of soil for the 216-A-36B Crib, no construction-trench-worker evaluation was performed for this waste site.

The fraction of material within the 200 m^2 exposure area that is contaminated is calculated as the volume of material in a 1-m wide by 4.6 m deep trench through the longest dimension of the waste site, divided by the total trench volume of 918 m^3 described in Section DB2.1. This fraction then is multiplied by the shallow-zone maximum concentration (DOE/RL-2004-25, Table 4-12) to calculate construction-trench-worker EPCs.

For the "cover" alternative, construction-trench-worker EPCs are calculated according to:

> shallow-zone maximum concentration (pCi/g) × {[waste site length (m) × trench depth (4.6 m) × trench width (1 m)] / 918 m^3}.

For the "no-cover" alternative, construction-trench-worker EPCs are calculated according to:

> shallow-zone maximum concentration (pCi/g) × {[waste site length (m) × [trench depth (4.6 m) – cover depth (m)] × trench width (1 m)] / 918 m^3}.

For both "cover" and "no-cover" alternatives, the value of waste site length (m) × trench depth (4.6 m) × trench width (1 m) is constrained to be equal to or less than 918 m^3, so that the volume of excavated material from a waste site cannot exceed the total excavated volume. The value of the input parameter "cover depth" in RESRAD is set to zero for all construction-trench-worker runs, because the scenario reflects excavated material placed onto the ground surface. Inputs to these calculations are provided in Table DB2-3. Construction trench worker EPCs used as inputs to RESRAD are shown in Table DB2-2.

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[2] In RESRAD, "cover" refers to uncontaminated soil above the contaminated zone being modeled. If fill material is contaminated, as is the case with the 216-A-10 and the 216-B-12 Cribs, the waste site is modeled with a "no cover" RESRAD scenario.

Table DB2-3. Exposure-Point Concentration Inputs for the Construction Trench-Worker Scenario.

Parameter	216-B-12 Crib	216-A-19 Trench	216-A-10 Crib	216-A-36B Crib	216-A-37-1 Crib	207-A South Retention Basin	216-S-7 Crib
Length (m)	49	7.6	84	--[a]	213	17	30.5
Cover depth[b] (m)	0	4.3	0	--[a]	2.4	0.33	0

[a]No contaminants of potential concern were identified in the top 4.6 m of soil for the 216-A-36B Crib, and the depth to site-related contamination exceeds 7.5 m.

[b]Cover depth is based on the measured thickness of fill in borehole logs (DOE/RL-2004-25, *Remedial Investigation Report for the 200-PW-2 Uranium-Rich Process Waste Group and 200-PW-4 General Process Condensate Group Operable Units*, Table 1-2). "Cover" here refers to uncontaminated soil above the contaminated zone; the evaluation for the 216-B-12 and 216-A-10 is performed for radionuclides present in the fill overlying deeply-buried site-related contamination.

DB2.2.2 Well-Driller and Rural-Residential Scenario Soil Concentrations

Maximum detected concentrations of radionuclides in the 0 m to groundwater deep-zone soil layer of each waste site are used as the basis of the well-driller and rural-resident scenario calculations. The specific radionuclides and associated EPCs are those indicated in shading in the column labeled "Deep-Zone Maximum Concentration" in Table 4-12 of the RI Report (DOE/RL-2004-25). These data can be found in Table DB2-4.

Table DB2-4. Exposure-Point Concentrations for the Well-Driller and Rural-Residential Scenarios. (7 Pages)

Contaminant of Potential Concern	Background	Deep Zone Maximum Concentration	Well Driller	Rural Resident
207-A-South Retention Basin				
Americium-241	NA	4.9 E-02	1.8 E-03	3.5 E-04
Antimony-125	NA	ND		
Carbon-14	NA	ND		
Cesium-134	NA	ND		
Cesium-137	Fallout	1.07	4.0 E-02	7.7 E-03
Cobalt-60	Fallout	ND		
Europium-152	NA	ND		
Europium-154	Fallout	ND		
Europium-155	Fallout	7.7 E-02	2.9 E-03	5.5 E-04
Iodine-129	NA	ND		
Neptunium-237	NA	ND		
Nickel-63	NA	ND		
Niobium-94	NA	3.2 E-02	1.2 E-03	2.3 E-04
Plutonium-238	Fallout	ND		
Plutonium-239/240	Fallout	1.2 E-02	4.4 E-04	8.6 E-05

Table DB2-4. Exposure-Point Concentrations for the Well-Driller and Rural-Residential Scenarios. (7 Pages)

Contaminant of Potential Concern	Background	Deep Zone Maximum Concentration	Well Driller	Rural Resident
Potassium-40	16.6	NLA		
Radium-226	8.15 E-01	8.59 E-01	3.2 E-02	6.2 E-03
Radium-228	1.32	1.1		
Ruthenium-106	NA	ND		
Technetium-99	NA	ND		
Thorium-228[a]	1.32	7.37 E-01		
Thorium-230	1.10	1.26	4.7 E-02	9.0 E-03
Thorium-232	1.32	7.22 E-01		
Tin-126	NA	ND		
Strontium-90[b]	Fallout	1.4	5.2 E-02	1.0 E-02
Tritium	NA	16.6	0.61	0.12
Uranium-234	1.10	0.24		
Uranium-235	1.09 E-01	2.6 E-02		
Uranium-236	NA	NLA		
Uranium-238	1.06	0.27		
216-A-10 Crib				
Americium-241	NA	1,320	665	151
Antimony-125	NA	ND		
Carbon-14	NA	7.5	3.8	0.86
Cesium-134	NA	ND		
Cesium-137	Fallout	2,950	1,487	337
Cobalt-60	Fallout	ND		
Europium-152	NA	ND		
Europium-154	Fallout	0.2		
Europium-155	Fallout	5.4 E-02	2.7 E-02	6.2 E-03
Iodine-129	NA	38.8	20	4.4
Neptunium-237	NA	1.32 E-01	6.7 E-02	1.5 E-02
Nickel-63	NA	2.13	1.1	0.24
Niobium-94	NA	ND		
Plutonium-238	Fallout	316	159	36
Plutonium-239/240	Fallout	7,110	3,584	812
Potassium-40	16.6	27.2	13.7	3.1
Radium-226	8.15 E-01	0.82	0.41	9.4 E-02
Radium-228	1.32	1.27		
Ruthenium-106	NA	ND		
Technetium-99	NA	1.03		

Table DB2-4. Exposure-Point Concentrations for the Well-Driller and Rural-Residential Scenarios. (7 Pages)

Contaminant of Potential Concern	Background	Deep Zone Maximum Concentration	Well Driller	Rural Resident
Thorium-228 (a)	1.32	2.11		
Thorium-230	1.10	1.1		
Thorium-232	1.32	9.81 E-01		
Tin-126	NA	ND		
Strontium-90[b]	Fallout	44.7	23	5.1
Tritium	NA	835	759	172
Uranium-234	1.10	1.39	0.70	0.16
Uranium-235	1.09 E-01	2.27 E-01	0.11	2.6 E-02
Uranium-236	NA	NLA		
Uranium-238	1.06	1.22	0.62	0.14
216-A-19 Trench				
Americium-241	NA	8.1 E-02	5.8 E-03	1.1 E-03
Antimony-125	NA	ND		
Carbon-14	NA	ND		
Cesium-134	NA	ND		
Cesium-137	Fallout	7.2 E-02	5.2 E-03	1.0 E-03
Cobalt-60	Fallout	ND		
Europium-152	NA	ND		
Europium-154	Fallout	ND		
Europium-155	Fallout	6.6 E-02	4.7 E-03	8.8 E-04
Iodine-129	NA	ND		
Neptunium-237	NA	ND		
Nickel-63	NA	17.6	1.26	0.24
Niobium-94	NA	ND		
Plutonium-238	Fallout	ND		
Plutonium-239/240	Fallout	0.18	1.3 E-02	2.4 E-03
Potassium-40	16.6	NLA		
Radium-226	8.15 E-01	5.27 E-01		
Radium-228	1.32	5.92 E-01		
Ruthenium-106	NA	ND		
Technetium-99	NA	ND		
Thorium-228[a]	1.32	6.85 E-01		
Thorium-230	1.10	7.42 E-01		
Thorium-232	1.32	7.42 E-01		
Tin-126	NA	ND		
Strontium-90[b]	Fallout	20	1.44	0.27

Table DB2-4. Exposure-Point Concentrations for the Well-Driller and Rural-Residential Scenarios. (7 Pages)

Contaminant of Potential Concern	Background	Deep Zone Maximum Concentration	Well Driller	Rural Resident
Tritium	NA	4.24 E-01		
Uranium-234	1.10	6	0.43	8.0 E-02
Uranium-235	1.09 E-01	0.94	6.7 E-02	1.3 E-02
Uranium-236	NA	NLA		
Uranium-238	1.06	51	3.7	0.68
216-A-36B Crib				
Americium-241	NA	40,000	3,020	705
Antimony-125	NA	3.08 E-01	2.3 E-02	5.4 E-03
Carbon-14	NA	116	8.76	2.04
Cesium-134	NA	0.04	3.0 E-03	7.0 E-04
Cesium-137	Fallout	2.65 E+06	200,102	46,690
Cobalt-60	Fallout	623	47	11
Europium-152	NA	ND		
Europium-154	Fallout	1,800	136	32
Europium-155	Fallout	8.5 E-02	6.4 E-03	1.5 E-04
Iodine-129	NA	ND		
Neptunium-237	NA	ND		
Nickel-63	NA	181,000	13,667	3,189
Niobium-94	NA	ND		
Plutonium-238	Fallout	0.05	3.8 E-03	8.8 E-04
Plutonium-239/240	Fallout	98,000	7,400	1,727
Potassium-40	16.6	19.4	1.5	0.34
Radium-226	8.15 E-01	1.27	9.6 E-02	2.2 E-02
Radium-228	1.32	1.15		
Ruthenium-106	NA	ND		
Technetium-99	NA	41.9	3.16	0.74
Thorium-228 (a)	1.32	8.22 E-01		
Thorium-230	1.10	11.4	0.86	0.20
Thorium-232	1.32	4.85	0.37	0.09
Tin-126	NA	ND		
Strontium-90	Fallout	208,000	15,706	3,665
Tritium	NA	121	45.3	10.6
Uranium-234	1.10	81.3	6.1	1.4
Uranium-235	1.09 E-01	3.29	0.25	5.8 E-02
Uranium-236	NA	4.54	0.34	8.0 E-02
Uranium-238	1.06	70.9	5.4	1.2

Table DB2-4. Exposure-Point Concentrations for the Well-Driller and Rural-Residential Scenarios. (7 Pages)

Contaminant of Potential Concern	Background	Deep Zone Maximum Concentration	Well Driller	Rural Resident
216-A-37-1 Crib				
Americium-241	NA	0.02	1.4 E-02	2.8 E-03
Antimony-125	NA	ND		
Carbon-14	NA	ND		
Cesium-134	NA	ND		
Cesium-137	Fallout	1.13 E-01	7.8 E-02	1.6 E-02
Cobalt-60	Fallout	ND		
Europium-152	NA	ND		
Europium-154	Fallout	ND		
Europium-155	Fallout	4.3 E-02	3.0 E-02	5.9 E-03
Iodine-129	NA	ND		
Neptunium-237	NA	ND		
Nickel-63	NA	14.4	9.9	2.0
Niobium-94	NA	ND		
Plutonium-238	Fallout	ND		
Plutonium-239/240	Fallout	1.2 E-02	8.3 E-03	1.7 E-03
Potassium-40	16.6	9.15		
Radium-226	8.15 E-01	5.08 E-01		
Radium-228	1.32	5.81 E-01		
Ruthenium-106	NA	ND		
Technetium-99	NA	ND		
Thorium-228[a]	1.32	6.64 E-01		
Thorium-230	1.10	7.99 E-01		
Thorium-232	1.32	5.53 E-01		
Tin-126	NA	ND		
Strontium-90[b]	Fallout	1.7	1.2	0.23
Tritium	NA	267	184	37
Uranium-234	1.10	3.74 E-01		
Uranium-235	1.09 E-01	2.8 E-02		
Uranium-236	NA	NLA		
Uranium-238	1.06	3.96 E-01		
216-B-12 Crib				
Americium-241	NA	2	0.39	8.5 E-02
Antimony-125	NA	ND		
Carbon-14	NA	3.3	0.64	0.14
Cesium-134	NA	ND		

Table DB2-4. Exposure-Point Concentrations for the Well-Driller and Rural-Residential Scenarios. (7 Pages)

Contaminant of Potential Concern	Background	Deep Zone Maximum Concentration	Well Driller	Rural Resident
Cesium-137	Fallout	61,900	11,981	2,636
Cobalt-60	Fallout	ND		
Europium-152	NA	ND		
Europium-154	Fallout	ND		
Europium-155	Fallout	34.9	6.75	1.49
Iodine-129	NA	ND		
Neptunium-237	NA	4.8 E-02	9.3 E-03	2.0 E-03
Nickel-63	NA	ND		
Niobium-94	NA	ND		
Plutonium-238	Fallout	ND		
Plutonium-239/240	Fallout	3.9	0.75	0.17
Potassium-40	16.6	15.8		
Radium-226	8.15 E-01	1.05	0.20	4.5 E-02
Radium-228	1.32	1.02		
Ruthenium-106	NA	ND		
Technetium-99	NA	ND		
Thorium-228[a]	1.32	7.54	1.46	3.21 E-01
Thorium-230	1.10	1.19	0.23	5.1 E-02
Thorium-232	1.32	7.16 E-01		
Tin-126	NA	7.42 E-01	0.14	3.2 E-02
Strontium-90[b]	Fallout	12,700	2,458	541
Tritium	NA	8.28	1.60	3.53 E-01
Uranium-234	1.10	4.9	0.95	0.209
Uranium-235	1.09 E-01	0.32	0.06	1.4 E-02
Uranium-236	NA	NLA		
Uranium-238	1.06	5.1	0.99	0.22
216-S-7 Crib				
Americium-241	NA	1,900	686	110
Antimony-125	NA	NLA		
Carbon-14	NA	ND		
Cesium-134	NA	ND		
Cesium-137	Fallout	20,000	7,225	1,156
Cobalt-60	Fallout	2.2 E-02	7.9 E-03	1.3 E-03
Europium-152	NA	ND		
Europium-154	Fallout	ND		
Europium-155	Fallout	6.3 E-02	2.3 E-02	3.6 E-03

Table DB2-4. Exposure-Point Concentrations for the Well-Driller and Rural-Residential Scenarios. (7 Pages)

Contaminant of Potential Concern	Background	Deep Zone Maximum Concentration	Well Driller	Rural Resident
Iodine-129	NA	ND		
Neptunium-237	NA	6.8	2.5	0.39
Nickel-63	NA	13.7	4.9	0.79
Niobium-94	NA	NLA		
Plutonium-238	Fallout	190	69	11
Plutonium-239/240	Fallout	11,000	3,974	636
Potassium-40	16.6	16.2		
Radium-226	8.15 E-01	6.49 E-01		
Radium-228	1.32	8.46 E-01		
Ruthenium-106	NA	NLA		
Technetium-99	NA	14.7	5.3	0.85
Thorium-228[a]	1.32	4.78	1.7	0.28
Thorium-230	1.10	8.44 E-01		
Thorium-232	1.32	8.46 E-01		
Tin-126	NA	ND		
Strontium-90[b]	Fallout	53,000	19,147	3,064
Tritium	NA	1,410	509	82
Uranium-234	1.10	2,300	83	13
Uranium-235	1.09 E-01	25	9.0	1.4
Uranium-236	NA	NLA		
Uranium-238	1.06	200	72	12

Data presented for radionuclides with half-life greater than 1 year.
[a] Background value based on secular equilibrium with thorium-232.
[b] Strontium-90 value based on analysis of total radioactive strontium.
Fallout = not applicable; fallout radionuclide.
NA = not applicable.
ND = nondetect.
NLA = no laboratory analysis.

In the well-driller and rural-residential scenarios, contaminated materials are brought to the ground surface as a result of drilling a water well through a waste site. The depth to groundwater at the waste sites ranges between approximately 80 and 100 m, while the maximum cover depth at any waste site is approximately 4 m. Because the relative difference in the volume of well cuttings between "cover" and "no-cover" alternatives is negligible, the "no-cover" alternative is not evaluated for these scenarios.

The fraction of borehole cuttings that are contaminated is calculated as the thickness of contaminated soils at the waste site divided by the depth to groundwater. The thickness of contamination at each waste site used for these calculations is the same protective estimate that was used for the groundwater protection screening (DOE/RL-2004-25, Table 4-14):

216-B-12 Crib	18 m
216-A-19 Trench	5.6 m
216-A-10 Crib	48.9 m (88.2 m for tritium)
216-A-36B Crib	7.4 m (36.7 m for tritium)
216-A-37-1 Crib	58.5 m
207-A South Retention Basin	3 m
216-S-7 Crib	25 m (65 m for tritium).

For the well-driller scenario, EPCs are calculated according to:

shallow-zone maximum concentration (pCi/g) × {contamination thickness (m) / depth to groundwater (m)}.

For the rural-residential scenario, the well-driller EPCs are averaged over a 0.15 m layer of surface soil and calculated according to:

well driller EPC (pCi/g) × {well driller contaminated zone thickness (m) / 0.15 m}.

Well-driller and rural-resident EPCs used as inputs to RESRAD are shown in Table DB2-4.

DB2.3 OCCUPANCY AND DIETARY PARAMETERS

Site occupancy parameters in RESRAD are specified as the indoor and outdoor time factors. Both the construction trench worker and the well driller are assumed to be on site in an outdoor environment for a total of 40 hours (DOE/RL-2004-24). The exposure duration is set at one year.

The outdoor time factor for the construction-trench-worker and well-driller scenarios is calculated according to:

$$40\text{ h} / (365.25\text{ day/yr} \times 24\text{ h/day}) = 4.56\text{ E-03}.$$

The rural resident is assumed to spend 20 percent of annual time in the garden, 60 percent of annual time indoors, and 20 percent of annual time offsite, for an exposure duration of 30 years (DOE/RL-2004-24). The outdoor and indoor time factors for the rural-resident scenario are therefore 0.2 and 0.6, respectively.

Garden-produce ingestion parameters for the rural-residential scenario were obtained from WDOH/320-015, *Hanford Guidance for Radiological Cleanup*. The ingestion rate of fruits, vegetables, and grain is defined as 110 kg/yr. The leafy vegetable consumption rate is defined as 2.7 kg/yr. The fraction of plant food originating in the home garden is calculated internally in

RESRAD as a function of site area. Values of root depth, mass loading of soil on the leaves of produce, and other plant-related parameter values are maintained as RESRAD defaults.

One other RESRAD input parameter that is varied between the well driller and rural resident scenarios is the depth of the soil-mixing layer. This parameter is used in the soil-ingestion and dust-inhalation pathways to support calculation of the fraction of soil particles at the ground surface that are contaminated. For the well-driller scenario, the value is set equal to the contaminated-zone thickness shown in Table DB2-1. For the rural resident, the value is set equal to the assumed garden-mixing depth of 0.15 m.

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DB3.0 RESRAD RESULTS AND CONCLUSIONS

Radionuclides with maximum detected concentrations exceeding background screening values, or for which background values were unavailable or not applicable, were evaluated for potential human-health effects using the RESRAD computer program, Version 6.21 (ANL 2002). The results of RESRAD modeling for the construction-trench-worker, well-driller, and rural-residential intruder scenarios are discussed in this chapter. RESRAD radiation dose and cancer risk results are presented for the individual waste sites in Sections DB3.1 through DB3.7.

Radionuclide dose and cancer risk for each exposure pathway and radionuclide are summed to calculate the total dose to an individual. Cancer-risk estimates are evaluated relative to a target risk range of 10^{-6} (one in 1,000,000) to 10^{-4} (one in 10,000) described in 40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," A radiation dose of 15 mrem/yr, approximately equivalent to a 10^{-4} cancer risk, is used to evaluate exposure scenarios.

DB3.1 RESRAD RESULTS FOR THE 207-A SOUTH RETENTION BASIN

The radiation dose and cancer risk results for the 207-A South Retention Basin are shown in Table DB3-1. Health effects are modeled at 150 and 500 years in the future. The 207-A South Retention Basin is not backfilled, although the basins are lined with a 10.2 cm- (4-in.-) thick cement layer. This cement layer was modeled as earthen cover material. The ground surface for the RESRAD modeling was considered to be the base of the basin rather than the grade of the surrounding land surface.

Table DB3-1. Intruder-Scenario Dose and Risk-Assessment Results for the 207-A South Retention Basin.

Time (yr)	Construction-Trench Worker (Cover / No Cover)		Well Driller		Rural Residential	
	Dose (mrem/yr)	Risk	Dose (mrem/yr)	Risk	Dose (mrem/yr)	Risk
150	3.1 E-03 / 3.3 E-03	2.0 E-09 / 2.0 E-09	2.6 E-05	2.0 E-11	1.9 E-02	4.0 E-07
500	3.1 E-03 / 3.3 E-03	2.0 E-09 / 2.0 E-09	2.6 E-06	2.0 E-12	5.4 E-03	1.0 E-07

Construction-Trench Worker, Existing Cover. Radiation dose was below the target criterion of 15 mrem/yr, with values of $3.1 x 10^{-3}$ mrem at years 150 and 500. Cancer risk was within the 10^{-6} to 10^{-4} risk range at both times, with values of $2.0 x 10^{-9}$ at years 150 and 500. Health impacts are associated primarily with Ra-226 via external exposure at both times.

Construction-Trench Worker, No Cover. The results of the no-cover scenario were essentially identical to those described for the cover scenario.

Well Driller. Both radiation dose and cancer risk were far below the target criteria at years 150 and 500. Health impacts at year 150 are associated with Nb-94, Ra-226, Cs-137, and Th-230 via external exposure. At year 500, health impacts are related primarily to Nb-94 and, to a lesser extent, to Th-230 (dose) or Ra-226 (cancer risk), via external exposure.

Rural Resident. Radiation dose was below the target criterion of 15 mrem/yr, with values of $1.9x10^{-2}$ and $5.4x10^{-3}$ mrem at years 150 and 500, respectively. Cancer risk was below the 10^{-6} to 10^{-4} risk range at both times, with values of $4.0x10^{-7}$ and $1.0x10^{-7}$ at years 150 and 500, respectively. About 75 percent of radiation dose at year 150 is associated with Ra-226 via external exposure. At year 500, 80 percent of radiation dose is associated with Ra-226 and Th-230 via external exposure. At year 150 and 500 years, approximately 90 percent and 80 percent of cancer risk (respectively) is related to Ra-226 via external exposure.

DB3.2 RESRAD RESULTS FOR THE 216-A-10 CRIB

The radiation dose and cancer risk results for the 216-A-10 Crib are shown in Table DB3-2. Health effects are modeled at 150 and 500 years in the future. The depth of cover over the contaminated zone at the 216-A-10 Crib is approximately 9.1 m (30 ft). Therefore, the contaminated zone lies below the 0 m to 4.6 m (15-ft-) soil layer evaluated for possible surface exposure. Low concentrations of two radionuclides (K-40 and Ra-226) were measured at levels slightly above background, and one (Np-237) was measured where background data are unavailable. Although these radionuclides are present at very low concentrations in cover material, potential health effects related to surface exposure were evaluated to provide assurance that no significant impacts are likely under current site conditions. Because the depth of cover was so great, removing the cover to create a no-cover scenario was judged to be implausible, and a no-cover evaluation was not conducted.

Table DB3-2. Intruder-Scenario Dose and Risk-Assessment Results for the 216-A-10 Crib.

Time (yr)	Construction Trench Worker		Well Driller		Rural Residential	
	Dose (mrem/yr)	Risk	Dose (mrem/yr)	Risk	Dose (mrem/yr)	Risk
150	0.04	3.0 E-08	1.1	3.0 E-07	58	5.0 E-04
500	3.9 E-02	3.0 E-08	0.8	7.0 E-08	32	8.0 E-05

Construction-Trench Worker. Radiation dose was below the target criterion of 15 mrem/yr, with values of $0.04x10^{-2}$ and $3.9x10^{-2}$ mrem at years 150 and 500, respectively. Cancer risk was within the 10^{-6} to 10^{-4} risk range at both times, with a value of $3.0x10^{-8}$ years at both times. Health impacts are associated primarily with K-40 and, to a lesser extent, with Ra-226, via external exposure at both times.

Well Driller. Radiation dose was below the target criterion of 15 mrem/yr, with values of 1.1 and 0.8 mrem at years 150 and 500, respectively. Cancer risk was below the 10^{-6} to 10^{-4} risk range at both times, with values of $3.0x10^{-7}$ and $7.0x10^{-8}$ at years 150 and 500, respectively. Radiation dose at years 150 and 500 are associated with Pu-239 via inhalation and soil ingestion. Cancer risk at year 150 is related primarily to external exposure from Cs-137. At year 500, cancer risk is related primarily to Pu-239 via inhalation.

Rural Resident. Radiation dose was above the target criterion of 15 mrem/yr, with values of 58 and 32 mrem at years 150 and 500, respectively. Cancer risk was above the 10^{-6} to 10^{-4} risk range at both times, with values of $5.0x10^{-4}$ and $8.0x10^{-5}$ at years 150 and 500, respectively. About 80 percent of radiation dose at year 150 is associated with Cs-137 via external exposure and Pu-239 via inhalation and soil ingestion. At year 500, about 95 percent of radiation dose is associated with Pu-239 via soil ingestion, inhalation, and plant ingestion. At year 150, approximately 70 percent of cancer risk is related to Cs-137 via external exposure. At year 500, cancer risk is related primarily to Pu-239 via inhalation, soil ingestion, and plant ingestion.

DB3.3 RESRAD RESULTS FOR THE 216-A-19 TRENCH

The radiation dose and cancer risk results for the 216-A-10 Crib are shown in Table DB3-3. Health effects are modeled at 150 and 500 years in the future. The depth of cover over the contaminated zone at the 216-A-19 Trench is approximately 4.6 m (15 ft), suggesting that the contaminated zone exists below the 0 to 4.6 m- (15-ft-) soil layer evaluated for possible surface exposure. Several radionuclide COPCs (Am-241, Eu-155, Ni-63, Pu-239/240, Sr-90, U-234, U-235, U-238) were identified in a sample interval beginning at 4.4 m (14.5 ft) below ground surface. Although these radionuclides likely are predominantly from deeper than 4.6 m (15 ft), these radionuclides were evaluated as if they were present in a contaminated zone within 4.6 m (15 ft) of the ground surface.

Table DB3-3. Intruder-Scenario Dose and Risk-Assessment Results for the 216-A-19 Trench.

Time (yr)	Construction-Trench Worker (Cover / No Cover)		Well Driller		Rural Residential	
	Dose (mrem/yr)	Risk	Dose (mrem/yr)	Risk	Dose (mrem/yr)	Risk
150	6.5 E-05 / 9.7 E-04	4.0 E-11 / 5.0 E-10	3.9 E-06	1.0 E-12	5.4 E-04	6.0 E-09
500	3.1 E-05 / 4.6 E-04	2.0 E-11 / 3.0 E-10	1.0 E-06	1.0 E-13	1.0 E-04	5.0 E-10

Construction-Trench Worker, Existing Cover. Radiation dose was below the target criterion of 15 mrem/yr, with values of $6.5x10^{-5}$ and $3.1x10^{-5}$ mrem at years 150 and 500, respectively. Cancer risk was within the 10^{-6} to 10^{-4} risk range at both times, with values of $4.0x10^{-11}$ and $2.0x10^{-11}$ at years 150 and 500, respectively. Health impacts are associated primarily with U-238 via external exposure at both times.

Construction-Trench Worker, No Cover. Radiation dose was far below the target criterion of 15 mrem/yr at years 150 and 500. Cancer risk was also far below the 10^{-6} to 10^{-4} risk range at both times. Health impacts are associated primarily with U-238 via external exposure at both times.

Well Driller. Both radiation dose and cancer risk were far below the target criteria at years 150 and 500. Radiation dose at years 150 and 500 are associated primarily with Pu-239 via inhalation and soil ingestion, with 30 percent contribution from Cs-137 and Am-241 via external exposure at year 150. Cancer risk at year 150 is related primarily to Cs-137 and Am-241 via external exposure. At year 500, 50 percent% of cancer risk is related to Am-241 via external exposure (cancer risk), and 30 percent is related to Pu-239 via inhalation.

Rural Resident. Radiation dose was far below the target criterion of 15 mrem/yr at years 150 and 500. Cancer risk was below the 10^{-6} to 10^{-4} risk range at both times, with values of $6.0x10^{-9}$ and $5.0x10^{-10}$ at years 150 and 500, respectively. About 50 percent of radiation dose at year 150 is associated with Sr-90 via plant ingestion. At year 500, 70 percent of radiation dose is associated with Pu-239 via soil ingestion, inhalation, and plant ingestion. About 60 percent of cancer risk at year 150 is associated with Sr-90 via plant ingestion. At 500 years, approximately 60 percent of cancer risk is related to Am-241 and Ra-226 via external exposure.

DB3.4 RESRAD RESULTS FOR THE 216-A-36B CRIB

The radiation dose and cancer risk results for the 216-A-10 Crib are shown in Table DB3-4. Health effects are modeled at 150 and 500 years in the future. No radionuclide COPCs were identified above background levels in the shallow-zone soils at the 216-A-36B Crib. Therefore, the construction-trench-worker scenario was not evaluated for this waste site. The depth of cover over the contaminated zone at the 216-A-36B Crib is approximately 7.6 m (25 ft). Therefore, the contaminated zone exists below the 0 m to 4.6 m (15-ft) soil layer evaluated for possible surface exposure. No radionuclides were measured at concentrations exceeding background levels in the fill material. Because the depth of cover was so great, removal of the cover to create a no-cover scenario was judged to be implausible, and a no-cover scenario was not evaluated.

Table DB3-4. Intruder-Scenario Dose and Risk-Assessment Results for the 216-A-36B Crib.

Time (yr)	Construction-Trench Worker		Well Driller		Rural Residential	
	Dose (mrem/yr)	Risk	Dose (mrem/yr)	Risk	Dose (mrem/yr)	Risk
150	NA	NA	34	2.0 E-05	2,720	4.0 E-02
500	NA	NA	1.9	2.0 E-07	84	3.0 E-04

NA = not applicable.

Well Driller. Radiation dose was 34 mrem/yr at year 150, above the target criterion of 15 mrem/yr. By year 500, the dose rate had diminished to 1.9 mrem/yr. Cancer risks were at $2.0x10^{-5}$ at year 150 and $2.0x10^{-7}$ at year 500. Health impacts at year 150 are associated with Cs-137 via external exposure. At year 500, health impacts are related primarily to Pu-239 via inhalation and soil ingestion (and, for cancer risk, Am-241 via external exposure).

Rural Resident. Radiation dose was above the target criterion of 15 mrem/yr, with values of 2,720 and 84 mrem/yr at years 150 and 500, respectively. Cancer risk was above the 10^{-6} to 10^{-4} risk range at both times, with values of $4.0x10^{-2}$ and $3.0x10^{-4}$ at years 150 and 500, respectively. Health impacts at year 150 are associated almost entirely with Cs-137 via external exposure. At year 500, 80 percent of radiation dose is associated with Pu-239 via soil ingestion, inhalation, and plant ingestion. Cancer risk at year 500 is attributable to Pu-239 via soil ingestion, inhalation, and plant ingestion (45 percent) and to Am-241 via external exposure (40 percent).

DB3.5 RESRAD RESULTS FOR THE 216-A-37-1 CRIB

The radiation dose and cancer risk results for the 216-A-37-1 Crib are shown in Table DB3-5. Health effects are modeled at 150 and 500 years in the future.

Table DB3-5. Intruder-Scenario Dose and Risk-Assessment Results for the 216-A-37-1 Crib.

Time (yr)	Construction Trench Worker (Cover / No Cover)		Well Driller		Rural Residential	
	Dose (mrem/yr)	Risk	Dose (mrem/yr)	Risk	Dose (mrem/yr)	Risk
150	2.4 E-05 / 5.0 E-05	2.0 E-11 / 4.0 E-11	1.3 E-05	8.0 E-12	1.4 E-03	2.0 E-08
500	7.1 E-09 / 1.5 E-08	5.0 E-15 / 1.0 E-14	1.9 E-06	2.0 E-13	9.5 E-05	5.0 E-10

Construction-Trench Worker, Existing Cover. Radiation dose was far below the target criterion of 15 mrem/yr at years 150 and 500. Cancer risk also was far below the 10^{-6} to 10^{-4} risk range at both times. About 90 percent of radiation dose and cancer risk at years 150 and 500 is associated with Cs-137 via external exposure.

Construction-Trench Worker, No Cover. Radiation dose was far below the target criterion of 15 mrem/yr at years 150 and 500. Cancer risk also was far below the 10^{-6} to 10^{-4} risk range at both times. About 90 percent of radiation dose and cancer risk at years 150 and 500 is associated with Cs-137 via external exposure.

Well Driller. Both radiation dose and cancer risk were far below the target criteria at years 150 and 500. Radiation dose and cancer risk at year 150 are related primarily to Cs-137 via external exposure. At year 500, health effects primarily are caused by Pu-239 via inhalation and soil ingestion.

Rural Resident. Both radiation dose and cancer risk were far below the target criteria at years 150 and 500. About 80 to 85 percent of radiation dose and cancer risk at year 150 is attributable to Cs-137 via external exposure and, to a lesser extent, to Sr-90 via plant ingestion. At year 500, about 70 percent of radiation dose is related to Pu-239 via soil ingestion, inhalation, and plant ingestion. Cancer risk at year 500 is related primarily to Am-241 via external exposure, Pu-239 via inhalation and soil ingestion, and Ni-63 via plant ingestion.

DB3.6 RESRAD RESULTS FOR THE 216-B-12 CRIB

The radiation dose and cancer risk results for the 216-A-10 Crib are shown in Table DB3-6. Health effects are modeled at 150 and 500 years in the future. The depth of cover over the contaminated zone at the 216-B-12 Crib is approximately 9.0 m (30 ft). Therefore, the contaminated zone lies below the 0 to 4.6 m (15-ft) soil layer evaluated for possible surface exposure. Low concentrations of one radionuclide (Th-230) were measured at levels slightly above background, and low concentrations of two radionuclides were measured (Sn-126 and H-3) where background data are unavailable. Although these radionuclides are present at very low concentrations in "cover" material, potential health effects related to surface exposure were evaluated to provide assurance that no significant impacts are likely under current site conditions. Because the depth of "cover" was so great, removal of the "cover" to create a "no-cover" scenario was judged to be implausible, and a "no-cover" evaluation was not conducted.

Table DB3-6. Intruder-Scenario Dose and Risk-Assessment Results for the 216-B-12 Crib.

Time (yr)	Construction Trench Worker		Well Driller		Rural Residential	
	Dose (mrem/yr)	Risk	Dose (mrem/yr)	Risk	Dose (mrem/yr)	Risk
150	8.1 E-04	6.0 E-10	1.6	1.0 E-06	148	2.0 E-03
500	2.3 E-03	2.0 E-09	6.9 E-04	4.0 E-10	8.9 E-02	1.0 E-06

The RESRAD computer program library of radionuclides available for modeling does not contain Sn-126. Therefore, this radionuclide was not included in the simulation. Comparing ingestion, inhalation, and external dose conversion factors (DCF) for Sn-126 (maximum soil concentration of $7.42x10^{-1}$ pCi/g) and Th-230 (maximum soil concentration of 1.19 pCi/g) indicates that the contribution of Sn-126 to radiation dose still would result in dose well below the 15 mrem/yr target limit. Dose conversion factors used in RESRAD are taken from EPA/520/1-88/020, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, Federal Guidance Report 11, and EPA/402/R-93/081, *External Exposure to Radionuclides in Air, Water, and Soil*, Federal Guidance Report 12. Dose conversion factors for Sn-126 in EPA/520/1-88/020 and EPA/402/R-93/081 are $1.15x10^{-1}$ mrem/yr per pCi/cm^3, $1.95x10^{-5}$ mrem/pCi, and $9.95x10^{-5}$ mrem/pCi for external exposure, ingestion, and inhalation, respectively. Dose conversion factors for Th-230 in RESRAD are $1.51x10^{-3}$ mrem/yr per pCi/cm^3, $5.48x10^{-4}$ mrem/pCi, and $3.26x10^{-1}$ mrem/pCi for external exposure, ingestion, and inhalation, respectively.

Radiation dose from Th-230 is related primarily to soil ingestion and dust inhalation. In later years, external exposure related to Ra-226 and its progeny becomes more important as they ingrow from Th-230. The ingestion and inhalation DCFs of Sn-126 are smaller than the corresponding DCFs for Th-230. Similarly, the external DCF for Sn-126 is much smaller than that for Ra-226 (14 mrem/yr per pCi/cm^3). Therefore, it is unlikely that excluding Sn-126 from the RESRAD modeling significantly affected the results.

Construction-Trench Worker. Radiation dose was below the target criterion of 15 mrem/yr, with values of $8.1x10^{-4}$ and $2.3x10^{-3}$ mrem at years 150 and 500, respectively. Cancer risk was within the 10^{-6} to 10^{-4} risk range at both times, with values of $6.0x10^{-10}$ and $2.0x10^{-9}$ at years 150 and 500, respectively. Health impacts are associated primarily with Th-230 and its progeny Ra-226 via external exposure at both times.

Well Driller. Radiation dose was below the target criterion of 15 mrem/yr, with values of $1.6x10^{-4}$and $6.9x10^{-4}$ mrem at years 150 and 500, respectively. Cancer risk was within the 10^{-6} to 10^{-4} risk range at both times, with values of $1.0x10^{-6}$ and $4.0x10^{-10}$ at years 150 and 500, respectively. Health impacts at year 150 are solely associated with Cs-137 via external exposure. At year 500, about 70 percent of radiation dose and 90 percent of cancer risk is related to Cs-137 via external exposure.

Rural Resident. Radiation dose was 148 mrem/yr at year 150, above the target criterion of 15 mrem/yr. By year 500, the dose rate had diminished to $8.9x10^{-2}$ mrem/yr. Cancer risk was above the 10^{-6} to 10^{-4} risk range at year 150 ($2.0x10^{-3}$), but within the risk range at year 500 with a value of $1.0x10^{-6}$. About 95 percent of radiation dose and cancer risk at year 150 is associated with Cs-137 via external exposure. At year 500, 50 percent of health effects are associated with Cs-137 via external exposure, and the remainder largely are caused by Th-230 and its progeny Ra-226 and U-238 via external exposure.

DB3.7 RESRAD RESULTS FOR THE 216-S-7 CRIB

The radiation dose and cancer risk results for the 216-S-7 Crib are shown in Table DB3-7. Health effects are modeled at 150 and 500 years in the future. The depth of cover over the contaminated zoned at the 216-S-7 Crib is approximately 6.4 m (21 ft). Therefore, the contaminate zone lies below the 0 to 4.6 m (15 ft) soil layer evaluated for possible surface exposure. Low concentrations of two radionuclides (Cs-137 and H-3) were measure in the fill material overlying the crib. Potential health effects related to surface exposure were evaluated to provide assurance that no significant impacts are likely under current site conditions. Because the depth of cover was so great, removing the cover to create a no-cover scenario was judged to be implausible and a no-cover evaluation was not conducted.

Table DB3-7. Dose and Risk-Assessment Results for the Intruder Scenarios.

Time (yr)	Construction Trench Worker		Well Driller		Rural Residential	
	Dose (mrem/yr)	Risk	Dose (mrem/yr)	Risk	Dose (mrem/yr)	Risk
150	2.2 E-06	2.0 E-12	1.9	8.0 E-07	105	1.0 E-02
500	6.7 E-10	5.0 E-16	0.88	8.0 E-08	27	6.0 E-04

Construction-Trench Worker. Radiation dose was below the target criterion of 15 mrem/yr, with values of $2.2x10^{-6}$ and $6.7x10^{-10}$ mrem at years 150 and 500, respectively. Cancer risk was far below the 10^{-6} to 10^{-4} risk range at both times, with values of $2.0x10^{-12}$ and $5.0x10^{-16}$ at years 150 and 500, respectively. Health impacts are associated primarily with Cs-137 via external exposure at both times.

Well Driller. Radiation dose was below the target criterion of 15 mrem/yr, with values of 1.9 and 0.88 mrem at years 150 and 500, respectively. Cancer risk was below the 10^{-6} to 10^{-4} risk range at both times, with values of $8.0x10^{-7}$ and $8.0x10^{-8}$ at years 150 and 500, respectively. Health impacts at year 150 are associated with Cs-137 via external exposure, and with Pu-239 via inhalation and soil ingestion. At year 500, health impacts are related almost entirely to Pu-239 via inhalation and soil ingestion.

Rural Resident. Radiation dose exceeded the target criterion of 15 mrem/yr, with values of 105 and 27 mrem at years 150 and 500, respectively. Cancer risk was above the 10^{-6} to 10^{-4} risk range at both times, with values of $1.0x10^{-2}$ and $6.0x10^{-4}$ at years 150 and 500, respectively. About 60 percent of radiation dose at year 150 is associated with Cs-137 via external exposure, with approximately another 25 percent related to Pu-239 via soil ingestion, inhalation, and plant ingestion.

Cancer risk at year 150 is associated with Sr-90 and Cs-137 via external exposure. At year 500, approximately 80 percent of dose is related to Pu-239 via soil ingestion, inhalation, and plant ingestion, while cancer risk at 500 years is attributable primarily to Am-241 via external exposure.

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APPENDIX E

FURTHER EVALUATION OF RISK ASSESSMENT CONTAMINANTS OF CONCERN

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CONTENTS

TERMS

bgs	below ground surface
COC	contaminant of concern
EPA	U.S. Environmental Protection Agency
FS	feasibility study
K_d	distribution coefficient
OU	operable unit
p/b	parts per billion
RI	remedial investigation

APPENDIX E

FURTHER EVALUATION OF RISK ASSESSMENT CONTAMINANTS OF CONCERN

E1.0 FURTHER EVALUATION OF CONTAMINANTS OF CONCERN CARRIED FORWARD BY THE RISK ASSESSMENT

This appendix addresses the radiological and nonradiological contaminants carried forward to the feasibility study (FS) process by the 200-PW-2 and 200-PW-4 Operable Unit (OU) remedial investigation (RI) risk assessment and removed from further consideration as contaminants of concern (COC) at the identified site.

E1.1 NONRADIOLOGICAL CONTAMINANTS REMOVED AS CONTAMINANTS OF CONCERN

The radiological contaminants listed below were carried forward as waste-site-specific COCs from Tables 4-39 and 6-1 of the RI report (DOE/RL-2004-25, *Remedial Investigation Report for the 200-PW-2 Uranium-Rich Process Waste Group and 200-PW-4 General Process Condensate Group Operable Units*) for further evaluation during the FS process. The following nonradiological contaminants were detected at 200-PW-2 and 200-PW-4 OU waste sites during RI soil sampling and were identified in the RI risk assessment (Appendix D) as exceeding risk-screening levels, and so were carried forward for further evaluation during the FS process. Based on the evaluation presented in this appendix, the constituents can be removed from further consideration as COCs under the identified risk scenario at the identified 200-PW-2 or 200-PW-4 OU waste sites. These evaluation results are summarized in Tables 2-5 and 2-6 of the FS, and the evaluation methodology is detailed in Appendix E:

- Acetone – 216-A-37-1 Crib (ecological)
- Aluminum – 216-A-37-1 Crib (groundwater)
- Arsenic – 216-A-19 Trench (groundwater); 216-B-12 Crib (groundwater and ecological); 216-S-7 Crib (groundwater); 207-A South Retention Basin (groundwater and ecological)
- Barium – 216-A-37-1 Crib (ecological)
- Boron – 216-A-37-1 Crib (ecological); 216-A-19 Trench (ecological); 216-A-10 Crib (ecological); 216-B-12 Crib (ecological)
- Butylbenzyl phthalate – 207-A South Retention Basin (ecological)
- 2,4-dichlorophenoxy-acetic acid – 207-A South Retention Basin (ecological)
- 2-(2,4,5-trichlorphenoxy) propionic acid – 207-A South Retention Basin (ecological)

- B-BHC (beta-1,2,3,4,5,6-Hexachlorocyclohexane – 216-A-10 Crib (groundwater and ecological)
- bis(2-ethylhexyl) phthalate – 216-A-37-1 Crib (ecological); 216-A-19 Trench (ecological); 216-B-12 Crib (ecological)
- Chromium VI – 216-S-7 Crib (ecological)
- Manganese – 216-A-37-1 Crib (groundwater); 216-A-19 Trench (groundwater)
- Nitrate/nitrite – 207-A South Retention Basin (groundwater); 216-A-10 Crib (groundwater)
- Pentachlorophenol – 216-A-10 Crib (groundwater)
- Methylene chloride – 216-A-10 Crib (groundwater)
- Isophorone – 216-A-36B Crib (Groundwater)
- Oil and grease – 216-A-10 Crib (groundwater); 216-A-36B Crib (groundwater)
- Silver – 216-S-7 Crib (ecological); 216-A-36B Crib (ecological); 207-A South Retention Basin (ecological)
- Total petroleum hydrocarbon-kerosene – 216-A-10 Crib (groundwater)
- Tributyl phosphate – 216-A-37-1 Crib (ecological); 216-A-10 Crib (groundwater); 216-A-19 Trench (groundwater and ecological)
- Vanadium – 216-A-19 Trench (ecological).

Acetone. Acetone was carried forward to the FS as a possible ecological (terrestrial-wildlife) COC for the 216-A-37-1 Crib. However, this constituent has no ecological screening value identified in WAC 173-340-900, "Tables," Table 749-3. Acetone is a standard laboratory contaminant as discussed in EPA/540/R-99/008, *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*. At less than or equal to 50 µg/kg (p/b), acetone is considered to be indistinguishable from sample blanks. Further, SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-A*, has established a practical quantitation limit of 100 p/b for acetone in either groundwater or low soil/sediment. The maximum acetone concentration reported at the 216-A-37-1 Crib was 14.9 p/b at 29.7 m (97.5 ft) below ground surface (bgs) and so can be considered a laboratory artifact. This conclusion is corroborated by borehole data that show acetone laboratory results to be a mixture of nondetects and estimated (J-flagged) low concentrations associated with blank contamination (B-flagged) and that have no pattern of increasing or decreasing concentration. It is concluded that acetone detections are the result of laboratory contamination. Acetone was excluded as an ecological COC for the Central Plateau ecological assessment process, because it is highly volatile, very soluble in water, and reasonably biodegradable and so is unlikely to be present in soils.

Aluminum. Aluminum was carried forward as a groundwater protection COC at the 216-A-37-1 Crib. The maximum aluminum concentration (15,000 mg/kg) was below the 95 percent upper confidence limit background at the 216-A-37-1 Crib. The distribution coefficient (K_d) for aluminum is above a value of 40 L/kg and so is essentially immobile in the vadose zone and is not predicted to reach groundwater within 1,000 years. The groundwater risk-based concentration for aluminum is based on a U.S. Environmental Protection Agency (EPA) drinking water secondary maximum contaminant level. Based on this information, aluminum concentrations are protective of groundwater.

Arsenic. Arsenic was carried forward as a groundwater protection COC at the 216-A-19 Trench, 216-B-12 Crib, 207-A South Retention Basin, and 216-S-7 Crib. Arsenic was carried forward at the 216-B-12 Crib and 207-A South Retention Basin as a terrestrial-wildlife COC. As described below, arsenic will be removed from further consideration as a groundwater-protection and ecological COC at these sites.

Arsenic was detected at the 216-A-19 Trench in 7 of 11 samples, only one of which was slightly above background at 7.00 mg/kg at 4.4 m (14.5 ft) (background of 6.47 mg/kg), while all other detections were below background. This sample is flagged (J) as estimated because of interferences. Arsenic was detected at the 216-B-12 Crib in 10 of 10 samples, with only one detect slightly above background at 7.30 mg/kg at 4.4 m (14.5 ft), while all other detections were below background. Arsenic was reported in 10 of 13 samples from the 207-A South Retention Basin. Seven samples were below background, two were essentially at background of 6.67 mg/kg (0.3 m [1 ft]) and of 6.56 mg/kg (0.6 m [2 ft]), and one was slightly above background at 9.98 mg/kg (1.8 m [6 ft]). The 207-A South Retention Basin is concrete with an elastomeric lining (that has remained intact) to protect the soil column. No samples were taken below about 4.6 m (15 ft) bgs, because no contamination is expected to occur in the deeper soil layers. Arsenic was reported below or essentially at background at the 216-S-7 Crib in samples from 2.8 to 7.0 mg/kg from 7.3 to 48 m (24 to 157.5 ft) bgs. Arsenic is not expected to reach groundwater at any of these sites. Groundwater samples under the Plutonium-Uranium Extraction Plant cribs show arsenic near background levels (PNNL-15070, *Hanford Site Groundwater Monitoring for Fiscal Year 2004*). Arsenic has a K_d of 29 L/kg, correlating to very limited mobility in the vadose zone and so is not predicted to reach groundwater within 1,000 years.

Arsenic is not considered a terrestrial-wildlife exposure COC at either the 216-B-12 Crib or the 207-A South Retention Basin. The terrestrial wildlife screening level for arsenic is 7.0 mg/kg, using the more conservative background value for Arsenic III, not the 132 mg/kg value for Arsenic V. Arsenic was detected below or essentially at its ecological screening value and so is not a terrestrial-wildlife concern at the 207-A South Retention Basin. Further, given that concrete basins cover the site, no terrestrial-wildlife exposure to soil is plausible. Arsenic is not expected to be a terrestrial-wildlife concern at the 216-B-12 Crib, because it was reported only once at 7.30 mg/kg, which is only slightly above background (6.47 mg/kg) and is essentially at the screening value of Arsenic III of 7.0 mg/kg, while all other detections were below background, indicating that arsenic at the site is naturally occurring.

Manganese. Manganese was carried forward at the 216-A-19 Trench and the 216-A-37-1 Crib as a potential groundwater-protection COC. Manganese was detected at the 216-A-19 Trench in each of the 11 samples. However, only one sample (538 mg/kg at 5.3 m [17.5 ft] bgs) exceeded the Hanford Site background of 512 mg/kg. The K_d for manganese is 50 L/kg, so manganese is not predicted to reach groundwater within 1,000 years. Because only one sample result is above background and manganese is not predicted to reach groundwater at the 216-A-19 Trench, it is not a COC. Manganese exceeded the groundwater risk-based concentrations at the 216-A-37-1 Crib. Of 10 results, three samples and a field duplicate exceeded the background of 512 mg/kg at depths of 3.8, 22.1, and 29.7 m (12.5, 72.5, and 97.5 ft) bgs. The K_d for manganese is 50 L/kg, making it immobile in the vadose zone, and so manganese is not predicted to reach groundwater within 1,000 years. Wells down gradient have shown low concentrations of manganese, but this may be caused by the degradation of the well casings and screens (PNNL-14187, *Hanford Site Groundwater Monitoring for Fiscal Year 2002*). Based on this information, additional modeling to prove that manganese concentrations are protective of groundwater is not justified.

Methylene chloride. Methylene chloride was carried forward as a possible groundwater-protection COC for the 216-A-10 Crib. However, this constituent has no ecological screening value identified in WAC 173-340-900, Table 749-3. Methylene chloride is a common laboratory contaminant (EPA/540/R-94/082, *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses*). In accordance with data validation guidance, the sample should exceed the blank by a factor of 10 to be considered the result of contamination. Also, following SW-846 guidance, at less than or equal to 25 p/b, methylene chloride is considered to be indistinguishable from sample blanks. At the 216-A-10 Crib, the maximum methylene chloride concentration was reported as 29 µg/kg at a depth of 19 m (62.5 ft) bgs. This is less than a factor of 10 above the range of the method blank and is only slightly above the 25 µg/kg EPA-identified level that is indistinguishable from blanks. In addition, data from the borehole are a mixture of nondetects, low detections all flagged with "B," and no pattern of increasing or decreasing concentration, suggesting that the methylene chloride detections are from laboratory contamination. Although methylene chloride is a COC at the 200-PW-4 OU (DOE/RL-2000-60, *Uranium-Rich/General Process Condensate and Process Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan; Includes 200-PW-2 and 200-PW-4 Operable Units*), and methylene chloride plumes are present at the Hanford Site, no plumes are known near this crib, and methylene chloride is not a COC for the 200-PW-2 OU to which the 216-A-10 Crib and the 216-A19 Trench belong. Consequently, methylene chloride detections are believed to be caused by laboratory contamination.

Butylbenzyl phthalate. Butylbenzyl phthalate was carried forward as a potential terrestrial-wildlife COC at the 207-A South Retention Basin. However, this constituent has no ecological screening value identified in WAC 173-340-900, Table 749-3. Butylbenzyl phthalate is a semivolatile organic analyte reported at an estimated (J-flagged) maximum concentration of 110 µg/kg at a depth of 0.3 to 0.6 m (1 to 2 ft) bgs. There were no other detections (all U-flagged). Because the analytical results are qualified and without toxicity information with which to calculate a cleanup value, ecological risk is indeterminate, and further consideration as an ecological COC is not justified.

2,4-dichlorophenoxy-acetic acid and 2-(2,4,5-trichlorphenoxy) propionic acid. These chlorinated herbicides were carried forward as potential terrestrial-wildlife COCs for the 207-A South Retention Basin. However, these constituents have no ecological screening value identified in WAC 173-340-900, Table 749-3. Both chlorinated herbicides were reported in samples of shallow soil beneath the concrete 207-A South Retention Basin cells. The 2,4-dichlorophenoxy-acetic acid was detected in only one of seven analyzed samples at a maximum concentration of 0.007 mg/kg at 0.3 to 0.6 m (1 to 2 ft) bgs, which was an estimated value (J-flagged). The 2-(2,4,5-trichlorphenoxy) propionic acid was detected in only one of seven analyzed samples at a maximum concentration of 0.003 mg/kg, which was estimated (J-flagged). These herbicides are no longer in use. Such compounds are known to undergo biodegradation and photochemical degradation when subjected to surface conditions. At estimated concentrations in the very low parts per billion (p/b), and because the concrete structure provides no ecological habitat, ecological risk from these herbicides is insignificant, and further consideration as ecological COCs is not justified.

beta-1,2,3,4,5,6-Hexachlorocyclohexane (B-BHC). This compound is a chlorinated pesticide carried forward as a potential terrestrial-wildlife and groundwater-protection COC at the 216-A-10 Crib. The maximum concentration found in one surface sample was 0.007 mg/kg at 0.2 m (0.5 ft) bgs, which was collected for the purpose of waste disposal. Beta-1,2,3,4,5,6-Hexachlorocyclohexane is a pesticide that was used before the 1970s. It was carried forward to the FS because it has no ecological screening value identified in WAC 173-340-900, Table 749-3. However, a wildlife screening value of 6.0 mg/kg exists in Table 749-3 under the synonym enzene hexachloride. Because a wildlife value of 6.0 mg/kg exists, and the maximum beta-1,2,3,4,5,6-Hexachlorocyclohexane value is much smaller than the ecological screening value, no ecological risk exists, and further consideration as an ecological COC is not justified. As a pesticide, beta-1,2,3,4,5,6-Hexachlorocyclohexane was applied to the surface, was found only once in a surface sample in the low parts per billion, and is not anticipated to be found in the soil column. The K_d for such chemicals is 1.35 L/kg. Consequently, this contaminant has no reasonable potential to reach groundwater and so will be removed from further consideration as both a terrestrial-wildlife and a groundwater-protection COC.

Bis(2-ethylhexyl) phthalate. This chemical compound is a semivolatile organic analyte carried forward as a possible terrestrial-wildlife COC for the 216-A-19 Trench, 216-A-37-1 Crib, and 216-B-12 Crib. This constituent has no ecological screening value identified in WAC 173-340-900, Table 749-3. The maximum concentration reported in the 216-A-19 Trench shallow soils was 0.66 mg/kg at 4.4 m (14.5 ft) bgs, which was estimated (J-flagged). The maximum concentration reported in 216-B-12 Crib samples was 0.018 mg/kg at 4.4 m (14.5 ft) bgs and was J-flagged. The maximum concentration reported in 216-A-37-1 Crib samples was 0.021 mg/kg at 3.8 m (12.5 ft) bgs and 2.1 mg/kg at 5.3 m (17.5 ft) bgs. Because this is a standard laboratory contaminant (EPA/540/R-99/008, *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, Publication 9240.1-05A-P) and was reported at very low concentrations, ecological risk is insignificant and further consideration as an ecological COC is not justified.

Tributyl phosphate. Tributyl phosphate was carried forward as a potential terrestrial-wildlife COC at the 216-A-19 Trench and the 216-A-37-1 Crib and as a potential groundwater-protection COC at the 216-A-19 Trench and the 216-A-10 Crib. However, this constituent has no ecological screening value identified in WAC 173-340-900, Table 749-3. Tributyl phosphate is a semivolatile organic analyte that has no direct analytical method. It was reported in

216-A-37-1 Crib samples at a maximum concentration of 0.045 mg/kg at 3.8 m (12.5 ft) bgs and in 216-A-19 Trench samples at a maximum concentration of 280 mg/kg at 4.4 m (14.5 ft) bgs. Tributyl phosphate was excluded from Central Plateau ecological sampling as a COC, because it degrades in soil to phosphate and butanol, which already are identified as COCs, and is not a Washington State hazardous toxic substance or a 40 CFR 268.2, "Land Disposal Restrictions," "Definitions Applicable to this Part," underlying hazardous constituent. Because tributyl phosphate analysis corresponds to constituents that are separately reported, ecological risk already is considered, and further consideration as a separate terrestrial-wildlife COC is not justified.

Tributyl phosphate was found at the 216-A-10 Crib in the 15.9 to 26.7 m (52 to 87.5 ft) bgs depth range and exceeded screening levels in the 16.5 to 19.1 m (54 to 62.5 ft) bgs depth range. Three of the seven detections in the sample were well above the groundwater risk-based concentration of 6.18 mg/kg, and four were both below the risk-based concentration and at or below the detection limit. The highest detection, 2,000 mg/kg at 19.1 m (62.5 ft) bgs, was only 3.1 m (10 ft) above a much lower detection of 0.382 mg/kg. The detection at 26.7 m (87.5 ft) was even lower, 0.019 mg/kg, and was below the detection limit. Tributyl phosphate was reported in 216-A-19 Trench samples from a relatively shallow depth range, 4.4 to 9.9 m (14.5 to 32.5 ft) bgs. Of the six samples in which it was found, it exceeded screening levels in three. One detect was near the groundwater risk-based concentration, and two detects were near the detection limit. The RI Report identifies a tributyl phosphate K_d of 18.9 L/kg. Further, tributyl phosphate may biodegrade to an extent and is not expected to reach groundwater when released to soil. Previous modeling of constituents in Hanford Site soils indicates that materials with a K_d as high as 18.9 L/kg are not projected to reach groundwater in 1,000 years. Further, all groundwater searches of wells in the area are nondetects. Therefore, the tributyl phosphate concentrations are predicted to be protective of groundwater.

Hexavalent Chromium (Chrome VI). This metal was carried forward as a potential terrestrial-wildlife COC at the 216-S-7 Crib. The maximum concentration for this metal at the 216-S-7 Crib was 0.80 mg/kg at 4.4 to 5.2 m (14.5 to 17 ft) bgs. The ecological screening value identified for Chrome VI is not published in WAC 173-340-900, Table 749-3, but a wildlife value of 28.6 mg/kg has been calculated following the *Washington Administrative Code* methodology (WMP-20570, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report – Phase I*, Appendix D). Because the maximum concentration is well below the screening value, no ecological risk exists for this site, and further consideration as an ecological COC is not justified.

Pentachlorophenol. Pentachlorophenol, a semivolatile organic analyte, was carried forward as a groundwater protection COC for the 216-A-10 Crib. It was detected in one sample at 19 m (62.5 ft) bgs. The sample result of 20.4 µg/kg is flagged as estimated (J-flagged). This result is the only reported detection of this chemical in the OU. The concentration is below the minimum-detectable-activity range for this sample (300 to 200,000 µg/kg) and for the OU as a whole (100 to 200,000 µg/kg). The chemical is listed in DOE/RL-2001-54, *Central Plateau Ecological Evaluation*, as having exceeded a screening level during the risk calculation for the Central Plateau. However, this chemical is not likely to be present at the 216-A-10 Crib, because the waste site history does not include it. The broader 200 Areas ecological risk evaluation is addressing the ecological risk for this constituent. Consequently, this will be removed from consideration as a groundwater COC.

Oil and grease. Oil and grease were carried forward as a potential groundwater protection COC at the 216-A-10 and 216-A-36B Cribs. Oil and grease are organic compounds that have no published risk-based concentrations. The laboratory reported this as a constituent that is an indicator parameter ("CONV class") and not a specific analysis, and its reporting is intended primarily to give a general indication of the compound's presence or absence. This analysis corresponds to constituents that are separately reported as total petroleum hydrocarbon (aliphatic medium). The compounds can be petroleum-based oils and grease as well as natural materials such as animal lard, which was used extensively at the Hanford Site. The natural materials do not pose a human-health risk. These are typically large, insoluble long-chain fatty acids that are not likely to be mobile in the vadose zone. At both the 216-A-10 Crib and the 216-A-36B Crib, the oil and grease results are believed to be a false detection because they were detected only twice at the 216-A-10 Crib, once at 3,620 mg/kg (16.3 m or 54 ft bgs) and again at 59,400 mg/kg (19.1 m or 62.5 ft bgs). All other results in the soil column were nondetects. At the 216-A-36B Crib, oil and grease were detected once in 11 samples, at 90 mg/kg (8.4 m [27.5 ft] bgs), and were flagged as being associated with a contaminated blank. All other results in the soil column are nondetects, and there were no total petroleum hydrocarbon detects at this site (which would be expected if oil and grease were present). Therefore, the reported detection at both cribs looks to be spurious, suggesting that the material is not likely in the soil.

Isophorone. Isophorone is a semivolatile organic analyte that was carried forward as a potential groundwater COC at the 216-A-36B Crib, because it exceeded the groundwater risk-based concentration. Isophorone has a partition coefficient of 0.0468. Previous modeling (PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*) has shown that constituents with low partition coefficients reach groundwater at the Hanford Site. However, the constituent was detected only twice (of 13 samples). Both detections were estimated (J-flagged), and only one was slightly above screening levels at 0.50 mg/kg with a risk-based concentration of 0.45 mg/kg. It was not detected at any other waste sites. This compound is not sufficiently concentrated or ubiquitous to be expected to reach groundwater and will be removed from consideration as a groundwater COC.

Total petroleum hydrocarbon-kerosene. Total petroleum hydrocarbon-kerosene is a diesel class constituent carried forward as a potential groundwater COC for the 216-A-10 Crib. Total petroleum hydrocarbon-kerosene was detected twice at 19.1 m (62.5 ft) bgs out of 14 total results. The other results in the soil column are nondetects. There are no published risk-based concentrations for this compound. Kerosene was used as a solvent at the Hanford Site. While K_ds are not presented for such chemical mixtures, they are very large molecules and are not likely to be mobile in the vadose zone. Degradation of groundwater, if based on two detections of a low-mobility compound, is not likely, and further consideration as a groundwater COC is not justified.

Silver. Silver was carried forward at the 207-A South Retention Basin, 216-A-36B Crib, and 216-S-7 Crib as a terrestrial-wildlife COC, because it exceeded 2.0 mg/kg. However, this value is the WAC 173-340-900, Table 749-3, ecological screening value for plant exposure to silver and is not applicable to terrestrial wildlife as the primary receptor in an industrial-use scenario.

A wildlife value of 10.5 mg/kg has been calculated for silver following *Washington Administrative Code* methodology (WMP-20570). Silver was detected at a maximum concentration of 6.13 mg/kg at the 207-A South Retention Basin, 3.12 mg/kg at the 216-A-36B Crib, and 1.2 mg/kg at the 216-S-7 Crib. Because these maximum concentrations are all below the silver 10.5 mg/kg screening value, silver provides no ecological risk at this site, and further consideration as an ecological COC is not justified.

Nitrate/nitrite. Nitrate/nitrite was carried forward at the 207-A South Retention Basin and the 216-A-10 Crib as groundwater-protection COCs. The concentrations at this site are based on exceedance of the 4.0 screening value for nitrite. However, at the Hanford Site, 40 mg/kg is more applicable for nitrate/nitrite in soils that are primarily nitrates (DOE/RL-2004-23, *Hanford Facility Annual Dangerous Waste Report Calendar Year 2003*). Because nitrate/nitrite at maximum concentration of 20.9 mg/kg at the 207-A South Retention Basin and 25.8 mg/kg at the 216-A-10 Crib did not exceed 40 mg/kg, the nitrate/nitrite has been removed from further consideration as a groundwater-protection COC.

Boron. Boron was carried forward at the 216-A-10 Crib, 216-A-19 Trench, 216-A-37-1 Crib, and 216-B-12 Crib as ecological COCs (terrestrial wildlife). Boron has no terrestrial-wildlife screening value identified in WAC 173-340-900, Table 749-3. Without a calculated cleanup value, ecological risk is indeterminate, and further consideration as an ecological COC is not justified. Boron has a K_d value of 3.0 and generally is considered only a moderately mobile contaminant in vadose-zone soils.

Vanadium. Vanadium was carried forward at the 216-A-19 Trench as an ecological COC, because it exceeded 2.0 mg/kg. However, this value is the WAC 173-340-900, Table 749-3, ecological screening value for plant exposure to vanadium and is not applicable to terrestrial wildlife as the primary receptor in an industrial-use scenario. The vanadium terrestrial-wildlife screening value is 2.02 mg/kg (WMP-20570). Further, vanadium was found only in very low concentrations and has an extremely high K_d (1,000 mL/g), making it immobile in soil and posing no reasonable groundwater risk. The Hanford Site background concentration for vanadium ranges from 85.1 mg/kg (lognormal 90 percent) to 110 mg/kg (95 percent upper confidence limit). Because the maximum concentration of 96.0 mg/kg in shallow soils is within this range and reasonably can be attributable to natural background, vanadium will be removed from further consideration as an ecological COC.

Barium. Barium was carried forward at the 216-A-37-1 Crib as an ecological COC. Barium background ranges from 132 mg/kg (lognormal 90 percent) to 165 mg/kg (95 percent upper confidence level). Barium has a terrestrial-wildlife value of 1.0 mg/kg. The maximum barium concentration in shallow soil is 165 mg/kg at 3.8 m (12.5 ft) bgs, which essentially is within the range of Hanford Site background. Barium is variable throughout the soil column, ranging from 44.9 mg/kg (60 m or 197.5 ft bgs) to 193 mg/kg (29.7 m or 97.5 ft bgs). Barium has a high K_d value (41 mL/g), making it immobile in soil (FS, Section 2.6). The variability of barium in the soil column, given its low mobility in the soil column, suggests that barium concentrations are attributable to natural background levels and not to site activities.

E1.2 RADIOLOGICAL CONTAMINANTS REMOVED AS CONTAMINANTS OF CONCERN

The radiological contaminants listed below were carried forward as waste-site-specific COCs from Tables 4-39 and 6-1 of the RI Report (DOE/RL-2004-25) for further evaluation during the FS process. As described below, these constituents will be removed from further consideration as COCs for the identified exposure scenario at the identified waste site(s). These evaluation results are summarized in Table 2-6 of the FS and the evaluation methodology is detailed in Appendix E:

- Potassium-40 – 216-A-10 Crib (ecological)
- Thorium-230 – 216-B-12 Crib (ecological); 207-A South Retention Basin (ecological)
- Niobium-94 – 207-A South Retention Basin (ecological)
- Neptunium-237 – 216-A-10 Crib (ecological)
- Tin-126 – 216-B-12 Crib (ecological)
- Nickel-63 – 216-A-19 Trench (ecological)
- Technetium-99 – 216-S-7 Crib (groundwater).

Potassium-40. Potassium-40 was carried forward at the 216-A-10 Crib as a potential ecological (terrestrial-wildlife) COC. The maximum K-40 reported in 216-A-10 Crib shallow soil samples was 18.7 pCi at 3.8 m (12.5 ft). Potassium-40 has no ecological screening value (biota concentration guide) defined by the appropriate guidance, making ecological risk from this contaminant indeterminate, and further consideration as an ecological COC is not justified. Further, K-40 was excluded from the Central Plateau ecological risk assessment, because it is a naturally occurring radionuclide that was not produced by Hanford Site operations.

Thorium-230. Thorium-230 was carried forward at the 216-B-12 Crib and the 207-A South Retention Basin for further evaluation as a potential ecological (terrestrial-wildlife) COC. The maximum Th-230 concentration reported in 216-B-12 Crib shallow-zone samples was 1.19 pCi at 4.4 m (14.5 ft). This concentration essentially is at background (1.10 pCi/g). The maximum concentration of Th-230 in 207-A South Retention Basin shallow soils was 1.26 pCi at 0.3 to 0.6 m (1 to 2 ft). Thorium-230 does not have an ecological screening value (biota concentration guide) defined by the appropriate guidance, making ecological risk from this contaminant indeterminate, and further consideration as an ecological COC is not justified. Further, Th-230 was excluded from the Central Plateau ecological risk assessment, because it is a progeny radionuclide that builds insignificant activities within 50 years and can be estimated from the U-238 parent.

Niobium-94. Niobium-94 was carried forward at the 207-A South Retention Basin as a potential ecological (terrestrial-wildlife) COC. The maximum concentration of Nb-94 in shallow-zone soils was 0.032 pCi/g at 0.6 to 0.9 m (2 to 3 ft), which is beneath the concrete basin. Niobium-94 has no established site background value or ecological screening value (biota concentration guide) defined by the appropriate guidance, making ecological risk from such a low concentration of this contaminant indeterminate, and further consideration as an ecological COC is not justified. Further, Nb-94 was excluded from the Central Plateau ecological risk assessment, because modeling (ORIGEN 2 code [ORNL-5621, *ORIGEN2-A Revised and*

Updated Version of the Oak Ridge Isotope Generation and Depletion Code]) of high burn-up N Reactor fuels shows yields of less than 10 pCi/g, and chemical process further diluted this constituent such that it can be found only at concentrations near detection level.

Tin-126. Tin-126 was carried forward at the 216-B-12 Crib as a potential ecological (terrestrial-wildlife) COC. The maximum Sn-126 concentration in 216-B-12 Crib shallow-zone soil samples was 0.742 pCi/g at 4.4 m (14.5 ft). Tin-126 has no established background value and no ecological screening value (biota concentration guide) defined by the appropriate guidance, making ecological risk from this very low contaminant concentration indeterminate, and further consideration as an ecological COC is not justified. Further, Sn-126 was excluded from the Central Plateau ecological risk assessment, because it was generated during chemical-processing operations at a rate of $<5x10^{-5}$ times the Cs-137 activity, making the quantities generated insignificant.

Neptunium-237. Neptunium-237 was carried forward as a potential ecological (terrestrial-wildlife) COC at the 216-A-10 Crib. The maximum Np-237 concentration reported in 216-A-10 Crib shallow soil samples was 0.043 pCi/g at 3.8 m (12.5 ft). Neptunium-237 has no established background value. However, neptunium has a biota concentration guide value of 1,900 pCi/g (DOE/RL-2005-40, *100-B/C Pilot Project Risk Assessment Report*). Because the maximum shallow-soil concentration of Np-237 is less than this biota concentration guide value, further consideration as an ecological COC is unjustified.

Nickel-63. Nickel-63 was carried forward as a potential ecological (terrestrial-wildlife) COC at the 216-A-19 Trench. The maximum Ni-63 concentration in 216-A-19 Trench shallow-soil samples was 17.6 pCi at 4.4 m (14.5 ft). Nickel-63 has no established background value and no ecological screening value (biota concentration guide) defined by the appropriate guidance. Consequently, ecological risk from this contaminant concentration is indeterminate, and further consideration as an ecological COC is unjustified. However, an ecological screening value was calculated for Ni-63 of 108,000 pCi/g (DOE/RL-2005-40) and at the 17.6 pCi/g concentration is well below this value.

Tritium. Tritium was carried forward as a potential groundwater-protection COC at the 216-S-7 Crib. Conservative modeling predicted a maximum tritium dose of 4.6 mrem/yr and a rate of $1x10^{-4}$ at year 30, dropping below the 4 mrem/yr target dose by approximately year 35. Because tritium concentrations in site soils will only slightly exceed groundwater-protection standards for a short duration within the remedial-action period when the site controls remain in place, use of groundwater by remediation workers as drinking water is precluded; tritium provides no risk and will be removed from further consideration as a groundwater-protection COC at this site.

E2.0 REFERENCES

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APPENDIX F

COST ESTIMATE BACKUP

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CONTENTS

FIGURE

TABLES

TERMS

ACP	asphalt concrete pavement
AFL-CIO	American Federation of Labor-Congress of Industrial Organizations
bgs	below ground surface
CWC	Central Waste Complex
D&D	deactivation and decommissioning
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ET	evapotranspiration
FH	Fluor Hanford, Inc.
FICA	*Federal Insurance Contributions Act*
FP	fixed price
FS	feasibility study
FY	fiscal year
G&A	general and administrative
HSSA	*Hanford Site Stabilization Agreement*
IDW	investigation-derived waste
INEEL	Idaho National Engineering and Environmental Laboratory
LPG	liquid propane gas
MAESTRO Estimator	cost model developed by Fluor Hanford, Inc.
MCACES	*Micro-Computer Aided Cost Engineering System* database
OMB	Office of Management and Budget
PUREX	Plutonium-Uranium Extraction Plant
QA	quality assurance
RCT	radiological control technician
REDOX	Reduction-Oxidation Plant
RTD	removal, treatment, and disposal
SWB	standard waste box
TRU	waste materials contaminated with more than 100 nCi/g of transuranic materials having half-lives longer than 20 years
WIPP	Waste Isolation Pilot Project

APPENDIX F

COST ESTIMATE BACKUP

F1.0 INTRODUCTION

Cost estimates for the feasibility study (FS) have an accuracy of +50 percent, -30 percent, which is the accuracy specified in EPA/540/R-00/002, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, OSWER 9355.0-75. The cost estimates provide a discriminator for deciding between similar protective and implemental alternatives for a specific waste site. Therefore, the costs are relational, not absolute, costs for the evaluation of the alternatives. Cost estimates by waste site were developed using the MAESTRO Estimator cost models developed by Fluor Hanford (FH) Project Controls Estimating department. This FS does not evaluate the economies associated with implementing multiple sites or groups with a common alternative or aggregated remediation. They will be considered in the future as part of long-range planning and through the post-record-of-decision activities, such as remedial design. Potential areas of cost sharing to reduce overall remediation costs include the following:

- Remediating all waste sites with a common preferred alternative at the same time
- Sharing mobilization/demobilization costs
- Sharing surveillance and maintenance costs
- Sharing barrier performance monitoring costs.

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F2.0 ALTERNATIVE COST ESTIMATES

This chapter describes the cost estimates based on the remedial alternatives developed in Chapter 6.0 of the FS. This chapter also summarizes the alternatives considered and the total present-worth costs, and provides summary and backup information for costs by waste site or group.

Present-net-worth costs were estimated using the real discount rate published in Appendix C of the Office of Management and Budget (OMB) Circular No. A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, which is effective through the end of January 2004. Programs with durations longer than 30 years use the 30-year interest rate of 3.1 percent. Present-net-worth costs are discussed for each alternative in the following subsections.

Non-discounted costs were calculated because of recommendations presented in EPA/540/R-00/002. Non-discounted constant dollar costs demonstrate the impact of a discount rate on the total present value cost. The non-discounted costs are presented for comparison purposes only.

F2.1 ALTERNATIVE 1 – NO ACTION

The no-action alternative represents a situation where no legal restrictions, access controls, or active remedial measures are applied to the waste site. Taking no action implies "walking away from the waste site" and allowing the waste to remain in its current configuration, affected only by natural processes. No maintenance or other activities would be instituted or continued. Chapter 6.0 of the FS describes the no-action alternative.

Because the no-action alternative assumes no further actions will be taken at a waste site, costs are assumed to be zero.

F2.2 ALTERNATIVE 2 – MAINTAIN EXISTING SOIL COVER, MONITORED NATURAL ATTENUATION, AND INSTITUTIONAL CONTROLS

Chapter 6.0 of the FS provides a description of the Maintain Existing Soil Cover, Monitored Natural Attenuation, and Institutional Controls alternative. Cost models for each representative site are discussed in detail in Section F3.2. The primary annual/periodic costs associated with this alternative are surveillance and cover maintenance and monitored natural attenuation costs. This alternative also includes the cost of long term groundwater monitoring. The costs for these annual/periodic activities were estimated based on the area of the individual waste sites or groups. Tables F-3 through F-7 provide details of the capital and annual/periodic cost estimates.

The unit cost for surveillance and maintenance was assumed to be the same as the current unit cost for surveillance and maintenance activities conducted annually on the waste sites. The unit cost accounts for such activities as site radiation surveys, and repair of the existing soil cover on the sites where it is present. Because the existing soil cover is maintained annually, costs for replacing all or large portions of the existing cover at specified intervals (i.e., every 20 years) are considered unnecessary.

The costs associated with natural attenuation monitoring are divided into three components: radiological surveys of surface soils, spectral gamma logging of vadose zone boreholes, and groundwater monitoring. The costs to perform radiological surveys of surface soils at waste sites are assumed to be similar to those for current survey practices at the sites and are included in the surveillance and maintenance costs.

Vadose zone monitoring costs assume spectral gamma logging of one borehole per waste site to a 15 m (50 ft) depth once every 5 years until the site meets all preliminary remediation goals. This monitoring is considered for sites with high concentrations of contaminants in the shallow zone or near the bottom of crib and trench structures. It also assumes that the service life of vadose zone boreholes is 30 years. Costs are included for logging and periodic replacement of these boreholes until all preliminary remediation goals are met for the site.

Groundwater monitoring costs likely will be incurred for sites that have high concentrations of mobile contaminants deep within the vadose zone and/or where groundwater contamination is known to have occurred. However, for the purpose of this FS the groundwater sampling activity will be considered as a periodic cost.

Institutional controls, which can have one-time or recurring costs (capital, annual operations and maintenance, or periodic), are non-engineering or legal/administrative measures to reduce or minimize the potential for exposure to site contamination or hazards by limiting or restricting site access.

Examples include institutional controls plan, restrictive covenants, property easements, zoning, deed notices, advisories, groundwater use restrictions, and site information database. An institutional controls plan would describe the controls for a site and how to implement them. A site information database would provide a system for managing data necessary to characterize the current nature and extent of contamination. Institutional controls are project-specific costs that can be an important component of a remedial alternative and, as such, should generally be estimated separately from other costs, usually on a sub-element basis. Institutional controls may need to be updated or maintained, either annually or periodically.

The institutional control cost model used for this alternative was developed by the FH Project Controls and Estimating Department. The duration for institutional controls only considers the initial, "Year-one" period. The annual/periodic activities were based on the length of time required to reach the preliminary remediation goals of 150 years.

The combined present-net-worth costs for surveillance and maintenance, natural attenuation monitoring and institutional control activities represent the present-worth cost for this alternative. The real discount rate of 3.1 percent is used for discounting real (constant-dollar) flows for the duration until all preliminary remediation goals are reached at each site. The non-discounted cost for the 150-year project duration is presented for comparison purposes.

F2.3 ALTERNATIVE 3 – REMOVAL, TREATMENT, AND DISPOSAL

Chapter 6.0 of this FS describes the remove-and-dispose alternative. Cost models for each representative site are discussed in detail in Section F3.3. Cost estimates for the removal, treatment, and disposal alternative are provided in Tables F-8 and F-9. Table F-1 lists the excavation depths for this alternative.

Annual/periodic and institutional control costs were not added to the removal, treatment, and disposal alternative because the contaminants are assumed to be removed to concentrations at or below the preliminary remediation goals. This alternative removes the human health and ecological risks associated with the contaminated soils at each site evaluated in this FS.

The remove-and-dispose construction activities represent the present-worth cost for this alternative. The real discount rate of 3.1 percent is used for discounting real (constant-dollar) flows for the duration until all preliminary remediation goals are reached at each site. The non-discounted cost for the 150-year project duration is presented for comparison purposes.

F2.4 ALTERNATIVE 4 – CAPPING

Chapter 6.0 of this FS provides a description of the capping alternative. Cost models for each representative site are discussed in detail in Section F3.4. Cost estimates for the capping alternative are included in Tables F-10 through F-13. Figure F-1 shows details of the assumed cap design for the Hanford Barrier and Biological Barrier.

Operation and maintenance costs for the capping alternative include barrier performance monitoring and repair costs. For purposes of this FS, all sites will assume annual repairs to the cap (replacement of 15.2 cm [2 ft] of topsoil layer and revegetation over 10 percent of the barrier area). This is considered a conservative estimate because the barrier has been designed to require minimal maintenance, particularly after vegetation has been established.

Institutional controls are an integral component of the capping alternative and would be required to prevent both intrusion to the capped area and activities that might alter the integrity and effectiveness of the cap. Groundwater monitoring likely would be a part of the capping alternative. However, the cost estimate considers groundwater sampling periodic costs. Therefore, they are not considered in the capital cost estimates.

The institutional control cost model used for this alternative was developed by the FH Project Controls and Estimating Department. The duration for institutional controls only considers the initial, "year-one" period. The annual/periodic activities were based on the length of time required to reach the preliminary remediation goals of 150 years.

The combined present-net-worth costs for remove-and-dispose construction activities, surveillance and maintenance; natural attenuation monitoring and institutional control activities represent the present-worth cost for this alternative. The real discount rate of 3.1 percent is used for discounting real (constant-dollar) flows for the duration until all preliminary remediation goals are reached at each site. The non-discounted cost for the 150-year project duration is presented for comparison purposes.

F2.5 ALTERNATIVE 5 – PARTIAL REMOVAL, TREATMENT, AND DISPOSAL WITH CAPPING

Chapter 6.0 of this FS provides a description of the removal, treatment, and disposal with capping alternative. Cost models for each representative site are discussed in detail in Section F3.5. Cost estimate inputs for this alternative are included in Tables F-14 through F-17.

Under Alternative 5, the removal of contaminants by excavation extends to a depth of 5 ft below the bottom point of greatest radionuclide activity, as shown in the table included in Section F3.5. The excavation would be filled with borrow material obtained on the Hanford Site. When the backfilling operation is finished, the site would be capped. These activities remove a significant fraction of the near-surface contaminant load and still provide protection to groundwater from deeper contaminants that are impractical to remove. The removal, treatment, disposal, and capping activities would be the same as described for Alternatives 3 and 4.

Most of the groundwater protection contaminants are located deeper in the vadose zone; therefore, the removal of contaminants from the zone shown on the table included in Section F3.5 would not significantly change the groundwater risk. The capping activity provided in this alternative would address protection of groundwater from the remaining contaminants in the vadose zone. Institutional controls would be required for this alternative because contamination remains on site above preliminary remediation goals.

The institutional control costs present-net-worth costs for the alternative are added to reach the total present-worth cost for this alternative. The real discount rate of 3.1 percent is used for discounting real (constant-dollar) flows for the duration until all preliminary remediation goals are reached at each site. The non-discounted cost for the 150-year project duration is presented for comparison purposes.

F3.0 ASSUMPTIONS

Assumptions used for the Alternative 3, 4, and 5 are discussed in the following sections.

F3.1 GLOBAL ASSUMPTIONS

F3.1.1 Labor

- Fixed-price (FP) construction craft labor rates are those listed in Appendix A of the *Site Stabilization Agreement for All Construction Work for the U.S. Department of Energy at the Hanford Site* (commonly known as the Hanford Site Stabilization Agreement [HSSA]). The HSSA rates include base wage, fringe benefits, and other compensation as negotiated between FH and the National Building and Construction Trades Department American Federation of Labor-Congress of Industrial Organizations (AFL-CIO). Other factors to cover additional costs for Workman's Compensation, *Federal Insurance Contributions Act* (FICA) and state and Federal unemployment insurance to develop a fully burdened rate by craft have been incorporated. The labor rates used are for 2005.

- FH labor rates for management, engineering, safety oversight, and technical support are based on the FH approved planning rates for fiscal year (FY) 2005.

F3.1.2 Markups

F3.1.2.1 Direct Cost Factors

- Sales tax has been applied to all materials and equipment purchases at 8.3 percent.

- Construction consumables are estimated at 3.5 percent of FP direct craft labor costs to allow for small tools, tape, plastics, gloves, etc.

- General supervisor factor of 3 percent has been applied to FP craft labor hours.

F3.1.2.2 Indirect Cost Factors

- FP contractor overhead, profit, bond, and insurance costs have been applied at 26.5 percent on FP labor, materials, and equipment.

- FH general and administrative (G&A) of 15 percent has been applied to all FH labor, material, and equipment. The G&A also is applied to the FP contractor costs.

F3.1.3 General Assumptions

- FH cost estimating templates for site remediation were used as the basis for each waste site. Standard templates used include trench/ditch/crib, retention basin, deep excavation, Hanford Barrier, Biological Barrier, and ET Capillary Barrier.
- Construction labor, material, and equipment units have been estimated based on standard commercial estimating resources and databases: Means 2001, *ECHOS Environmental Remediation Cost Data – Unit Price*, and *Facility Construction Cost Data*; Richardson's *Process Plant Construction Estimating Standards*; and the U.S. Army Corps of Engineers MCACES database, *Micro-Computer Aided Cost Engineering System*. The units may have been factored or adjusted by the estimator as appropriate to reflect influences by contract, work site, or other identified project or special conditions.
- Quotes from local commercial sources have been used for materials that need to be acquired for the construction of barriers or temporary improvements.
- Equipment rates are based on 21 working days per month.
- Equipment operation is based on one shift of 8 hours per day.
- Workweek equals 5 days per week.
- Work stoppages or shutdowns due to inclement weather are not factored into the estimates or planning schedules for this study.
- Work delays or stoppages due caused by waiting for laboratory results or approval for backfilling waste site excavations are not factored into the estimates or planning schedules for this study.
- The cost estimates include costs for design, work plan preparation, or any other preparation costs normally associated with activities occurring before field mobilization.
- Remedial design capital costs are based on EPA/540/R-00/002, Exhibit 5-8. The following guide is used in this study:
  - For projects with construction costs less than $100,000 – Remedial design is planned at 20 percent of construction costs.
  - For projects with construction costs from $100,000 to $500,000 – Remedial design is planned at 15 percent of construction costs.
  - For projects with construction costs from $500,000 to $2 million – Remedial design is planned at 12 percent of construction costs.

- For projects with construction costs from \$2 million to \$10 million – Remedial design is planned at 8 percent of construction costs.

- For projects with construction costs greater than \$10 million – Remedial design is planned at 6 percent of construction costs.

- Escalation has not been included in the calculations. All costs are present day (FY 2005).

- Contingency rates are based on Section 5.4 of EPA/540/R-00/002.

F3.1.4 Long-Term Groundwater Monitoring Costs

Each alternative that includes annual inspections and maintenance costs (Alternatives 2, 4, and 5) will include a cost for periodic groundwater monitoring. The cost associated with periodic groundwater monitoring is distributed equally over applicable closure zones. The following is a description of the periodic groundwater costs.

Periodic groundwater sampling will be performed in each closure zone located at the facility. Each closure zone will contain three monitoring wells that will be sampled during the periodic sampling event. The present-worth cost for the periodic groundwater-monitoring program will be the same for each closure zone. That cost then will be divided equally among the sites within that closure zone. A summary of the facility closure zones associated with this FS is presented as follows.

Closure Zone	Number of Sites in Each Closure Zone
Reduction-Oxidation Plant (REDOX)	47
200 East Area Ponds	55
B Plant	56
Plutonium-Uranium Extraction Plant (PUREX)	72
Hot Semiworks Plant	28
S/U Farm	39
200 West Area Ponds	28
T Farm	58

Based on historical information from similar Hanford Site planning, the cost to install a compliant monitoring well is approximately \$180,000 per well. It is assumed that this cost includes all required labor and material.

- Cost to install wells (3 wells) = \$180,000/well x 3 wells
  = \$540,000.

Maintenance will be performed on each of the wells every 5 years during the 150-year active monitoring period. In addition, each of the wells will be replaced once every 30 years.

- Maintenance costs (3 wells) = \$5,000/well x 3 wells = \$15,000 every 5 years
- Replacement costs (3 wells) = \$180,000/well x 3 wells = \$540,000 every 30 years.

During each sampling event, three groundwater samples will be collected for analysis. The analyses and cost per analysis are listed below.

- Cs-137 = \$180/sample x 3 samples/event = \$540/event
- Sr-90 as total radiostrontium = \$353/sample x 3 samples/event = \$1,059/event.

Total analytical cost per sampling event = \$1,599.

The labor cost of doing all the paperwork, labeling, monitoring, and delivery to the laboratory is approximately \$300 per well sampled.

- Total labor cost = \$300/well x 3 wells = \$900/sampling event.

Total cost to collect and analyze samples per sampling event = \$5,322.

Sampling events will occur at the following frequencies:

- Year 1 Quarterly (4 sampling events)
- Year 2 Semi-annually (2 sampling events)
- Years 3 through 5 Annually (3 sampling events)
- Years 6 through 10 Every 2 years (3 sampling events)
- Years 11 through 50 Every 5 years (8 sampling events)
- Years 51 through 150 Every 10 years (10 sampling events).

The present-worth cost to conduct a periodic groundwater-monitoring program for each closure zone for 150 years was calculated.

Present-worth cost for long-term groundwater program = \$557,583.

As a comparison, the non-discounted present-worth cost for long-term groundwater program was calculated to compare the effect of a discount rate on the total project cost.

Present-worth non-discounted costs for long-term groundwater program = \$3,089,808.

The present-worth cost, on a per site basis, will be added to the calculated costs presented in Tables F-7, F-13, and F-17. Because there are a different number of sites in each closure zone, the following table presents the long-term groundwater monitoring cost per site for each closure zone. The non-discounted long-term groundwater monitoring cost per site is presented in parentheses.

Closure Zone	Number of Sites in Each Closure Zone	Cost Per Site
REDOX	47	$11,863 ($65,741)
200 East Area Ponds	55	$10,138 ($56178)
B Plant	56	$9,957 ($55,175)
PUREX	72	$7,744 ($42,914)
Hot Semiworks Plant	28	$19,914 ($110,350)
S/U Farm	39	$14,297 ($79,226)
200 West Area Ponds	28	$19,914 ($110,350)
T Farm	58	$9,614 ($53,272).

Lastly, the following table lists the sites included in this FS, their associated closure zone, and the cost that will be added into the costs for Alternatives 2, 4, and 5 presented in Tables F-7, F-13, and F-17. Non-discounted costs are presented in parentheses.

Closure Zone: REDOX	Cost per site: $11,863 ($65,741)
216-S-8 Trench	216-S-1&2 Crib; UPR-200-W-36
216-S-22 Crib	200-W-22 Site Group
216-S-7 Crib	
Closure Zone: 200 East Area Ponds	Cost per site: $10,138 ($56178)
216-A-19 Trench	216-A-1 Crib
216-A-18 Trench	216-A-20 Trench & Overflow
216-A-34 Ditch	UPR-200-E-145
207-A South Retention Basin	
Closure Zone: B Plant	Cost per site: $9,957 ($55,175)
216-B-12 Crib	216-B-60 Crib
270-E-1 Neutralization Tank	UPR-200-E-64
Closure Zone: PUREX	Cost per site: $7,744 ($42,914)
216-A-3 Crib	216-A-22 French Drain and UPR-200-E-17
216-A-28 Crib	216-A-10 Crib
216-A-5 Crib	216-A-45 Crib
200-E-58 Neutralization Tank	216-A-36B Crib
216-A-36A Crib	UPR-200-E-39
216-A-37-1 Crib	

Closure Zone: Hot Semiworks Plant	Cost per site: $19,914 ($110,350)
216-C-3 Crib	216-C-5 Crib
216-C-7 Crib	216-C-10 Crib
209-E-WS-3 Valve Pit and Hold-Up Tank	216-C-1 Crib
Closure Zone: S/U Farms	Cost per site: $14,297 ($79,226)
216-S-23 Crib	
Closure Zone: 200 West Area Ponds	Cost per site: $19,914 ($110,350)
216-S-4 French Drain	
Closure Zone: T Farm	Cost per site: $9,614 ($53,272)
216-T-20 Trench	

F3.2 ALTERNATIVE 2 – MAINTAIN EXISTING SOIL COVER, MONITORED NATURAL ATTENUATION, AND INSTITUTIONAL CONTROLS

F3.2.1 General Assumptions

The general assumptions for Alternative 2 are as follows:

- Similar to the cost estimates for Alternatives 3, 4, and 5, Alternative 2 costs were calculated for each of the sites. Because it is not practical to present backup for all of the sites, cost descriptions only were developed for the representative sites. Using the processes presented in the representative site cost backup text presented in this appendix, equations were used to calculate the cost for each site using the specific area of each site. These calculated costs are presented in Table F-6.

- Site areas range from less than 100 ft^2 to more than 1,000,000 ft^2. Because of this difference, larger construction crews will be used for sites larger than 100,000 ft^2. For example, existing cover maintenance will use five trucks to haul material to the site for areas larger than 100,000 ft^2 and one truck for sites less than 100,000 ft^2.

- Fencing and monuments/signs for institutional controls and fencing maintenance are considered institutional costs and are considered in this cost estimate.

- Periodic groundwater monitoring costs will be added to Table F-6 as indicated in Section F3.1.4.

- Alternative 2 consists of seven general activities: implementation of institutional controls, site inspection and surveillance, existing cover maintenance, natural attenuation monitoring, reporting, site reviews, and monitoring. These activities are described for the representative sites in the following sections.

- The prices that make up the cost estimate were obtained from one of the following sources:
  - Means 2001, *ECHOS Environmental Remediation Cost Data – Unit Price*
  - Means 2004, *Facility Construction Cost Data.*
  - Experience on similar projects.

F3.2.2 Representative Waste Site 216-A-19 Trench

Institutional Controls Implementation: Preparing and implementing institutional controls is a capital cost and includes office or administrative costs to implement deed restrictions, land-use restrictions, and groundwater-use restrictions. Costs presented in the cost estimates are based on the following:

- Time to produce institutional controls = 200 hours (assumption)
- Labor rate = \$56/h (assumption).

Site Inspection and Surveillance: The cost associated with site inspection and surveillance is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. The activities performed under site inspection and surveillance include radiation surveys of surface soil and physical site inspection. Activities may include control of deeply burrowing animals and deep-rooted plants by using herbicide or by physical removal (cost for these items is not included).

<u>Site radiation surveys</u>: For costing purposes, sites 1 acre or smaller are assumed to cost \$8,712 for every surveying event. An additional \$1,000 will be required for site radiation surveys for every additional 5,000 ft^2 of site area larger than 1 acre.

- Area of representative site = 625 ft^2 (see Table F-1)
  = minimum 1 acre
- Radiation surveys of surface soil = \$8,712/event (\$1,000/5,000 ft^2).

<u>Physical site inspection</u>: For costing purposes, sites 1 acre (43,560 ft^2) or smaller are assumed to require a team of two inspectors to perform the activities associated with site inspection and surveillance. Additional crew time will be needed for site inspection and surveillance for site areas larger than 1 acre.

The cost for site inspection and surveillance is based on the following.

- Area of representative site = 625 ft^2 (see Table F-1)
- Cost to complete inspection = minimum 1 acre
  = \$781/acre.

Existing Cover Maintenance: The cost associated with existing cover maintenance is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. Because cover maintenance is performed annually, including costs for replacing all or large portions of the existing cover at specified intervals is unnecessary. Rather, cover maintenance is assumed to include replacing cover soils over 10 percent of the area to a depth of 2 ft. The soil used to repair the existing cover is a silt loam and pea gravel mixture. The pea gravel is used to make the soil resistant to wind erosion.

For costing purposes, it is assumed that the silt loam can be acquired for no material cost from an onsite borrow source (Area C) and that pea gravel must be purchased at an offsite location. Both materials (silt loam and pea gravel) must be mixed before being transported and placed at the site. It is assumed that periodically a large volume of silt and pea gravel will be mixed and stockpiled by a subcontractor at Area C. This mixture will be used for the repair of barrier surfaces. The material and transportation cost of pea gravel, excavation and hauling of the silt, and the blending and stockpiling is estimated at $8.95/calendar year for the mixture in stockpile at Area C.

For representative sites with areas larger than 100,000 ft^2, it is assumed for transporting the silt loam/pea gravel mixture to the waste site, that one front-end loader with operator will load dump trucks for transportation to the site. To transport the silt loam to the site, it is assumed that five dump trucks and five drivers will be used and each dump truck will make two trips an hour to the site carrying 12 yd^3 per trip. For representative sites less than 100,000 ft^2, one front-end loader with one operator will directly load two dump trucks making two trips an hour to the site.

Once the material is at the waste site it is assumed that the silt loam/pea gravel mixture will be unloaded at the repair area and spread with a liquid propane gas (LPG) dozer over the area. A 3,000-gal water truck will be used for dust control during the spreading process. For sites with areas less than 100,000 ft^2, one LPG dozer will be used. For sites with areas larger than 100,000 ft^2, two LPG dozers will be used. Once the silt loam and pea gravel mixture is in place, these areas will be revegetated. It is assumed that a revegetation crew can reseed 1 acre in an hour.

In addition to the transportation, spreading, and revegetation costs, it is assumed that FH will have a site engineer onsite during cover maintenance activities to provide oversight.

For planning purposes, the repair of a 1-acre waste site will require 323 yd^3 of silt loam/pea gravel mixture, 3 hours to load and transport, 4 hours to spread, and 1 hour to reseed. With supervisory oversight, the cost per acre is $5,728. Waste sites less than 1 acre are assumed to cost the same as 1 acre.

The cover maintenance costs are calculated as follows:

- Cover maintenance (footprint of cover)
  - Area of cover system = 0.01 acre
    = minimum 1 acre
  - Area requiring repair (10% of total area) = 484 yd^2
  - Volume of cover repair (2 ft) = 323 yd^3
  - Oversight = 3 hours.

Monitoring for Natural Attenuation: The cost associated with natural attenuation monitoring is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. The cost for natural attenuation monitoring includes spectral gamma logging of vadose zone boreholes.

Vadose zone monitoring costs assume spectral gamma logging of one borehole per waste site to a depth of 50 ft once every 5 years. The service life of a vadose zone borehole is assumed to be 30 years.

Therefore, every 30 years a replacement borehole will be drilled. Costs are based on the following:

- Unit cost for vadose zone monitoring = \$75/ft of borehole
- Length of borehole drilling = 50 ft
- Cost of vadose zone monitoring = \$75/ft x 50 ft = \$3,750
- Installation cost of borehole = \$50/linear ft
- Length of borehole installation = 50 ft
- Oversight (assumption) = 1 day = 8 hours (\$56/h).

Other costs associated with installing replacement boreholes are included on the cost estimate sheets. These items include, but are not limited to, mobilization of a drill rig, decontamination of a drill rig, and handling of investigation-derived waste (IDW).

Reporting: Annual and periodic activities will be recorded in an annual report. The report will contain descriptions of activities that occurred during the year. Reports will contain all appropriate/required backup and material purchase information. The cost for the annual reports is based on the following assumption:

- Annual reports = \$10,000/report.

Site Reviews: The cost associated with site reviews is an operation and maintenance cost. This cost will be incurred every 5 years as long as the alternative is being used. Site reviews will be conducted to assess site conditions, evaluate the selected alternative, and determine whether additional steps toward remediation are required. The cost for the 5-year site reviews is based on the following assumption:

- 5-year site review = \$20,000/review.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate effectiveness of the remedy on groundwater quality. Refer to Section F3.1.4.

F3.2.3 Representative Waste Site 216-B-12 Crib

Institutional Controls Implementation: Preparing and implementing institutional controls is a capital cost and includes office or administrative costs to implement deed restrictions, land-use restrictions, and groundwater-use restrictions. Costs presented in the cost estimates are based on the following:

- Time to produce institutional controls = 200 hours (assumption)
- Labor rate = \$56/h (assumption).

Site Inspection and Surveillance: The cost associated with site inspection and surveillance is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. The activities performed under site inspection and surveillance include radiation surveys of surface soil and physical site inspection. Activities may include control of deeply burrowing animals and deep-rooted plants by using herbicide or by physical removal (cost for these items is not included).

Site radiation surveys: For costing purposes, sites 1 acre or smaller are assumed to cost \$8,712 for every surveying event. An additional \$1,000 will be required for site radiation surveys for every additional 5,000 ft^2 of site area larger than 1 acre.

- Area of representative site = 8,000 ft^2 (see Table F-1) = minimum 1 acre
- Radiation surveys of surface soil = \$8,712/event (\$1,000/5,000 ft^2).

Physical site inspection: For costing purposes, sites 1 acre (43,560 ft^2) or smaller are assumed to require a team of two inspectors to perform the activities associated with site inspection and surveillance. Additional crew time will be needed for site inspection and surveillance for site areas larger than 1 acre.

The cost for site inspection and surveillance is based on the following.

- Area of representative site = 8,000 ft^2 (see Table F-1)
- Cost to complete inspection = minimum 1 acre = \$781/acre.

Existing Cover Maintenance: The cost associated with existing cover maintenance is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. Because cover maintenance is performed annually, including costs for replacing all or large portions of the existing cover at specified intervals is unnecessary. Rather, cover maintenance is assumed to include replacing cover soils over 10 percent of the area to a depth of 2 ft. The soil used to repair the existing cover is a silt loam and pea gravel mixture. The pea gravel is used to make the soil resistant to wind erosion.

For costing purposes, it is assumed that the silt loam can be acquired for no material cost from an onsite borrow source (Area C) and that pea gravel must be purchased at an offsite location. Both materials (silt loam and pea gravel) must be mixed before being transported and placed at the site. It is assumed that periodically a large volume of silt and pea gravel will be mixed and stockpiled by a subcontractor at Area C. This mixture will be used for the repair of barrier surfaces. The material and transportation cost of pea gravel, excavation and hauling of the silt, and the blending and stockpiling is estimated at $8.95/yd^3 for the mixture in stockpile at Area C.

For representative sites with areas larger than 100,000 ft^2, it is assumed for transporting the silt loam/pea gravel mixture to the waste site, that one front-end loader with operator will load dump trucks for transportation to the site. To transport the silt loam to the site, it is assumed that five dump trucks and five drivers will be used and each dump truck will make two trips an hour to the site carrying 12 yd^3 per trip. For representative sites less than 100,000 ft^2, one front-end loader with one operator will directly load two dump trucks making two trips an hour to the site.

Once the material is at the waste site, it is assumed that the silt loam/pea gravel mixture will be unloaded at the repair area and spread with an LPG dozer over the area. A 3,000-gal water truck will be used for dust control during the spreading process. For sites with areas less than 100,000 ft^2, one LPG dozer will be used. For sites with areas larger than 100,000 ft^2, two LPG dozers will be used. Once the silt loam and pea gravel mixture is in place, these areas will be revegetated. It is assumed that a revegetation crew can reseed 1 acre in an hour.

In addition to the transportation, spreading, and revegetation costs, it is assumed that FH will have a site engineer onsite during cover maintenance activities to provide oversight.

For planning purposes, the repair of a 1-acre waste site will require 323 yd^3 of silt loam/pea gravel mixture, 3 hours to load and transport, 4 hours to spread, and 1 hour to reseed. With supervisory oversight, the cost per acre is $5,728. Waste sites less than 1 acre are assumed to cost the same as 1 acre.

The cover maintenance costs are calculated as follows:

- Cover maintenance (footprint of cover)
  - Area of cover system = 0.18 acres
    = minimum 1 acre
  - Area requiring repair (10% of total area) = 484 yd^2
  - Volume of cover repair (2 ft) = 323 yd^3
  - Oversight = 3 hours.

Monitoring for Natural Attenuation: The cost associated with natural attenuation monitoring is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. The cost for natural attenuation monitoring includes spectral gamma logging of vadose zone boreholes.

Vadose zone monitoring costs assume spectral gamma logging of one borehole per waste site to a depth of 50 ft once every 5 years. The service life of a vadose zone borehole is assumed to be 30 years. Therefore, every 30 years a replacement borehole will be drilled. Costs are based on the following:

- Unit cost for vadose zone monitoring = $75/ft of borehole
- Length of borehole drilling = 50 ft

- Cost of vadose zone monitoring = \$75/ft x 50 ft = \$3,750
- Installation cost of borehole = \$50/linear ft
- Length of borehole installation = 50 ft
- Oversight (assumption) = 1 day = 8 hours (\$56/h).

Other costs associated with installing replacement boreholes are included on the cost estimate sheets. These items include, but are not limited to, mobilization of a drill rig, decontamination of a drill rig, and handling of IDW.

Reporting: Annual and periodic activities will be recorded in an annual report. The report will contain descriptions of activities that occurred during the year. Reports will contain all appropriate/required backup and material purchase information. The cost for the annual reports is based on the following assumption:

- Annual reports = \$10,000/report.

Site Reviews: The cost associated with site reviews is an operation and maintenance cost. This cost will be incurred every 5 years as long as the alternative is being used. Site reviews will be conducted to assess site conditions, evaluate the selected alternative, and determine whether additional steps toward remediation are required. The cost for the 5-year site reviews is based on the following assumption:

- 5-year site review = \$20,000/review.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate effectiveness of the remedy on groundwater quality. Refer to Section F3.1.4.

F3.2.4 Representative Waste Site 216-S-7 Crib

Institutional Controls Implementation: Preparing and implementing institutional controls is a capital cost and includes office or administrative costs to implement deed restrictions, land-use restrictions, and groundwater-use restrictions. Costs presented in the cost estimates are based on the following:

- Time to produce institutional controls = 200 hours (assumption)
- Labor rate = \$56/h (assumption).

Site Inspection and Surveillance: The cost associated with site inspection and surveillance is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. The activities performed under site inspection and surveillance include radiation surveys of surface soil and physical site inspection. Activities may include control of deeply burrowing animals and deep-rooted plants by using herbicide or by physical removal (cost for these items is not included).

Site radiation surveys: For costing purposes, sites 1 acre or smaller are assumed to cost $8,712 for every surveying event. An additional $1,000 will be required for site radiation surveys for every additional 5,000 ft^2 of site area larger than 1 acre.

- Area of representative site = 5,000 ft^2 (see Table F-1)
  = minimum 1 acre
- Radiation surveys of surface soil = $8,712/event ($1,000/5,000 ft^2).

Physical site inspection: For costing purposes, sites 1 acre (43,560 ft^2) or smaller are assumed to require a team of two inspectors to perform the activities associated with site inspection and surveillance. Additional crew time will be needed for site inspection and surveillance for site areas larger than 1 acre.

The cost for site inspection and surveillance is based on the following.

- Area of representative site = 5,000 ft^2 (see Table F-1)
- Cost to complete inspection = minimum 1 acre
  = $781/acre.

Existing Cover Maintenance: The cost associated with existing cover maintenance is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. Because cover maintenance is performed annually, including costs for replacing all or large portions of the existing cover at specified intervals is unnecessary. Rather, cover maintenance is assumed to include replacing cover soils over 10 percent of the area to a depth of 2 ft. The soil used to repair the existing cover is a silt loam and pea gravel mixture. The pea gravel is used to make the soil resistant to wind erosion.

For costing purposes, it is assumed that the silt loam can be acquired for no material cost from an onsite borrow source (Area C) and that pea gravel must be purchased at an offsite location. Both materials (silt loam and pea gravel) must be mixed before being transported and placed at the site. It is assumed that periodically a large volume of silt and pea gravel will be mixed and stockpiled by a subcontractor at Area C. This mixture will be used for the repair of barrier surfaces. The material and transportation cost of pea gravel, excavation and hauling of the silt, and the blending and stockpiling is estimated at $8.95/$yd^3$ for the mixture in stockpile at Area C.

For representative sites with areas larger than 100,000 ft^2, it is assumed for transporting the silt loam/pea gravel mixture to the waste site, that one front-end loader with operator will load dump trucks for transportation to the site. To transport the silt loam to the site, it is assumed that five dump trucks and five drivers will be used and each dump truck will make two trips an hour to the site carrying 12 yd^3 per trip. For representative sites less than 100,000 ft^2, one front-end loader with one operator will directly load two dump trucks making two trips an hour to the site.

Once the material is at the waste site it is assumed that the silt loam/pea gravel mixture will be unloaded at the repair area and spread with an LPG dozer over the area. A 3,000-gal water truck will be used for dust control during the spreading process. For sites with areas less than 100,000 ft^2, one LPG dozer will be used. For sites with areas larger than 100,000 ft^2, two LPG dozers will be used. Once the silt loam and pea gravel mixture is in place, these areas will be revegetated. It is assumed that a revegetation crew can reseed 1 acre in an hour.

In addition to the transportation, spreading, and revegetation costs, it is assumed that FH will have a site engineer onsite during cover maintenance activities to provide oversight.

For planning purposes, the repair of a 1-acre waste site will require 323 yd^3 of silt loam/pea gravel mixture, 3 hours to load and transport, 4 hours to spread, and 1 hour to reseed. With supervisory oversight, the cost per acre is $5,728. Waste sites less than 1 acre are assumed to cost the same as 1 acre.

The cover maintenance costs are calculated as follows:

- Cover maintenance (footprint of cover)
  - Area of cover system = 0.11 acre = minimum 1 acre
  - Area requiring repair (10% of total area) = 484 yd^2
  - Volume of cover repair (2 ft) = 323 yd^3
  - Oversight = 3 hours.

Monitoring for Natural Attenuation: The cost associated with natural attenuation monitoring is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. The cost for natural attenuation monitoring includes spectral gamma logging of vadose zone boreholes.

Vadose zone monitoring costs assume spectral gamma logging of one borehole per waste site to a depth of 50 ft once every 5 years. The service life of a vadose zone borehole is assumed to be 30 years. Therefore, every 30 years a replacement borehole will be drilled. Costs are based on the following:

- Unit cost for vadose zone monitoring = $75/ft of borehole
- Length of borehole drilling = 50 ft
- Cost of vadose zone monitoring = $75/ft x 50 ft = $3,750
- Installation cost of borehole = $50/linear ft
- Length of borehole installation = 50 ft
- Oversight (assumption) = 1 day = 8 hours ($56/h).

Other costs associated with installing replacement boreholes are included on the cost estimate sheets. These items include, but are not limited to, mobilization of a drill rig, decontamination of a drill rig, and handling of IDW.

Reporting: Annual and periodic activities will be recorded in an annual report. The report will contain descriptions of activities that occurred during the year. Reports will contain all appropriate/required backup and material purchase information. The cost for the annual reports is based on the following assumption:

- Annual reports = $10,000/report.

Site Reviews: The cost associated with site reviews is an operation and maintenance cost. This cost will be incurred every 5 years as long as the alternative is being used. Site reviews will be conducted to assess site conditions, evaluate the selected alternative, and determine whether additional steps toward remediation are required. The cost for the 5-year site reviews is based on the following assumption:

- 5-year site review = \$20,000/review.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate effectiveness of the remedy on groundwater quality. Refer to Section F3.1.4.

F3.2.5 Representative Waste Site 216-A-10 Crib

Institutional Controls Implementation: Preparing and implementing institutional controls is a capital cost and includes office or administrative costs to implement deed restrictions, land-use restrictions, and groundwater-use restrictions. Costs presented in the cost estimates are based on the following:

- Time to produce institutional controls = 200 hours (assumption)
- Labor rate = \$56/h (assumption).

Site Inspection and Surveillance: The cost associated with site inspection and surveillance is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. The activities performed under site inspection and surveillance include radiation surveys of surface soil and physical site inspection. Activities may include control of deeply burrowing animals and deep-rooted plants by using herbicide or by physical removal (cost for these items is not included).

Site radiation surveys: For costing purposes, sites 1 acre or smaller are assumed to cost \$8,712 for every surveying event. An additional \$1,000 will be required for site radiation surveys for every additional 5,000 ft^2 of site area larger than 1 acre.

- Area of representative site = 12,375 ft^2 (see Table F-1)
  = minimum 1 acre
- Radiation surveys of surface soil = \$8,712/event (\$1,000/5,000 ft^2).

Physical site inspection: For costing purposes, sites 1 acre (43,560 ft^2) or smaller are assumed to require a team of two inspectors to perform the activities associated with site inspection and surveillance. Additional crew time will be needed for site inspection and surveillance for site areas larger than 1 acre.

The cost for site inspection and surveillance is based on the following.

- Area of representative site = 12,375 ft^2 (see Table F-1)
- Cost to complete inspection = minimum 1 acre
  = \$781/acre.

Existing Cover Maintenance: The cost associated with existing cover maintenance is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. Because cover maintenance is performed annually, including costs for replacing all or large portions of the existing cover at specified intervals is unnecessary. Rather, cover maintenance is assumed to include replacing cover soils over 10 percent of the area to a depth of 2 ft. The soil used to repair the existing cover is a silt loam and pea gravel mixture. The pea gravel is used to make the soil resistant to wind erosion.

For costing purposes, it is assumed that the silt loam can be acquired for no material cost from an onsite borrow source (Area C) and that pea gravel must be purchased at an offsite location. Both materials (silt loam and pea gravel) must be mixed before being transported and placed at the site. It is assumed that periodically a large volume of silt and pea gravel will be mixed and stockpiled by a subcontractor at Area C. This mixture will be used for the repair of barrier surfaces. The material and transportation cost of pea gravel, excavation and hauling of the silt, and the blending and stockpiling is estimated at $8.95/yd^3$ for the mixture in stockpile at Area C.

For representative sites with areas larger than 100,000 ft^2, it is assumed for transporting the silt loam/pea gravel mixture to the waste site, that one front-end loader with operator will load dump trucks for transportation to the site. To transport the silt loam to the site, it is assumed that five dump trucks and five drivers will be used and each dump truck will make two trips an hour to the site carrying 12 yd^3 per trip. For representative sites less than 100,000 ft^2, one front-end loader with one operator will directly load two dump trucks making two trips an hour to the site.

Once the material is at the waste site, it is assumed that the silt loam/pea gravel mixture will be unloaded at the repair area and spread with an LPG dozer over the area. A 3,000-gal water truck will be used for dust control during the spreading process. For sites with areas less than 100,000 ft^2, one LPG dozer will be used. For sites with areas larger than 100,000 ft^2, two LPG dozers will be used. Once the silt loam and pea gravel mixture is in place, these areas will be revegetated. It is assumed that a revegetation crew can reseed 1 acre in an hour.

In addition to the transportation, spreading, and revegetation costs, it is assumed that FH will have a site engineer onsite during cover maintenance activities to provide oversight.

For planning purposes, the repair of a 1-acre waste site will require 323 yd^3 of silt loam/pea gravel mixture, 3 hours to load and transport, 4 hours to spread, and 1 hour to reseed. With supervisory oversight, the cost per acre is $5,728. Waste sites less than 1 acre are assumed to cost the same as 1 acre.

The cover maintenance costs are calculated as follows:

- Cover maintenance (footprint of cover)
  - Area of cover system = 0.28 acres
    = minimum 1 acre
  - Area requiring repair (10% of total area) = 484 yd^2
  - Volume of cover repair (2 ft) = 323 yd^3
  - Oversight = 3 hours.

Monitoring for Natural Attenuation: The cost associated with natural attenuation monitoring is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. The cost for natural attenuation monitoring includes spectral gamma logging of vadose zone boreholes.

Vadose zone monitoring costs assume spectral gamma logging of one borehole per waste site to a depth of 50 ft once every 5 years. The service life of a vadose zone borehole is assumed to be 30 years. Therefore, every 30 years a replacement borehole will be drilled. Costs are based on the following:

- Unit cost for vadose zone monitoring = \$75/ft of borehole
- Length of borehole drilling = 50 ft
- Cost of vadose zone monitoring = \$75/ft x 50 ft = \$3,750
- Installation cost of borehole = \$50/linear ft
- Length of borehole installation = 50 ft
- Oversight (assumption) = 1 day = 8 hours (\$56/h).

Other costs associated with installing replacement boreholes are included on the cost estimate sheets. These items include, but are not limited to, mobilization of a drill rig, decontamination of a drill rig, and handling of IDW.

Reporting: Annual and periodic activities will be recorded in an annual report. The report will contain descriptions of activities that occurred during the year. Reports will contain all appropriate/required backup and material purchase information. The cost for the annual reports is based on the following assumption:

- Annual reports = \$10,000/report.

Site Reviews: The cost associated with site reviews is an operation and maintenance cost. This cost will be incurred every 5 years as long as the alternative is being used. Site reviews will be conducted to assess site conditions, evaluate the selected alternative, and determine whether additional steps toward remediation are required. The cost for the 5-year site reviews is based on the following assumption:

- 5-year site review = \$20,000/review.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate effectiveness of the remedy on groundwater quality. Refer to Section F3.1.4.

F3.2.6 Representative Waste Site 216-A-36B Crib

Institutional Controls Implementation: Preparing and implementing institutional controls is a capital cost and includes office or administrative costs to implement deed restrictions, land-use restrictions, and groundwater-use restrictions. Costs presented in the cost estimates are based on the following:

- Time to produce institutional controls = 200 hours (assumption)
- Labor rate = \$56/h (assumption).

Site Inspection and Surveillance: The cost associated with site inspection and surveillance is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. The activities performed under site inspection and surveillance include radiation surveys of surface soil and physical site inspection. Activities may include control of deeply burrowing animals and deep-rooted plants by using herbicide or by physical removal (cost for these items is not included).

Site radiation surveys: For costing purposes, sites 1 acre or smaller are assumed to cost \$8,712 for every surveying event. An additional \$1,000 will be required for site radiation surveys for every additional 5,000 ft^2 of site area larger than 1 acre.

- Area of representative site = 5,500 ft^2 (see Table F-1) = minimum 1 acre
- Radiation surveys of surface soil = \$8,712/event (\$1,000/5,000 ft^2).

Physical site inspection: For costing purposes, sites 1 acre (43,560 ft^2) or smaller are assumed to require a team of two inspectors to perform the activities associated with site inspection and surveillance. Additional crew time will be needed for site inspection and surveillance for site areas larger than 1 acre.

The cost for site inspection and surveillance is based on the following.

- Area of representative site = 5,500 ft^2 (see Table F-1)
- Cost to complete inspection = minimum 1 acre = \$781/acre.

Existing Cover Maintenance: The cost associated with existing cover maintenance is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. Because cover maintenance is performed annually, including costs for replacing all or large portions of the existing cover at specified intervals is unnecessary. Rather, cover maintenance is assumed to include replacing cover soils over 10 percent of the area to a depth of 2 ft. The soil used to repair the existing cover is a silt loam and pea gravel mixture. The pea gravel is used to make the soil resistant to wind erosion.

For costing purposes, it is assumed that the silt loam can be acquired for no material cost from an onsite borrow source (Area C) and that pea gravel must be purchased at an offsite location. Both materials (silt loam and pea gravel) must be mixed before being transported and placed at the site. It is assumed that periodically a large volume of silt and pea gravel will be mixed and stockpiled by a subcontractor at Area C. This mixture will be used for the repair of barrier surfaces. The material and transportation cost of pea gravel, excavation and hauling of the silt, and the blending and stockpiling is estimated at \$8.95/yd^3 for the mixture in stockpile at Area C.

For representative sites with areas larger than 100,000 ft^2, it is assumed for transporting the silt loam/pea gravel mixture to the waste site, that one front-end loader with operator will load dump trucks for transportation to the site. To transport the silt loam to the site, it is assumed that five dump trucks and five drivers will be used and each dump truck will make two trips an hour to the site carrying 12 yd^3 per trip. For representative sites less than 100,000 ft^2, one front-end loader with one operator will directly load two dump trucks making two trips an hour to the site.

Once the material is at the waste site it is assumed that the silt loam/pea gravel mixture will be unloaded at the repair area and spread with an LPG dozer over the area. A 3,000-gal water truck will be used for dust control during the spreading process. For sites with areas less than 100,000 ft^2, one LPG dozer will be used. For sites with areas larger than 100,000 ft^2, two LPG dozers will be used. Once the silt loam and pea gravel mixture is in place, these areas will be revegetated. It is assumed that a revegetation crew can reseed 1 acre in an hour.

In addition to the transportation, spreading, and revegetation costs, it is assumed that FH will have a site engineer onsite during cover maintenance activities to provide oversight.

For planning purposes, the repair of a 1-acre waste site will require 323 yd^3 of silt loam/pea gravel mixture, 3 hours to load and transport, 4 hours to spread, and 1 hour to reseed. With supervisory oversight, the cost per acre is $5,728. Waste sites less than 1 acre are assumed to cost the same as 1 acre.

The cover maintenance costs are calculated as follows:

- Cover maintenance (footprint of cover)
  - Area of cover system = 0.13 acres
    = minimum 1 acre
  - Area requiring repair (10% of total area) = 484 yd^2
  - Volume of cover repair (2 ft) = 323 yd^3
  - Oversight = 3 hours.

Monitoring for Natural Attenuation: The cost associated with natural attenuation monitoring is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. The cost for natural attenuation monitoring includes spectral gamma logging of vadose zone boreholes.

Vadose zone monitoring costs assume spectral gamma logging of one borehole per waste site to a depth of 50 ft once every 5 years. The service life of a vadose zone borehole is assumed to be 30 years. Therefore, every 30 years a replacement borehole will be drilled. Costs are based on the following:

- Unit cost for vadose zone monitoring = $75/ft of borehole
- Length of borehole drilling = 50 ft
- Cost of vadose zone monitoring = $75/ft x 50 ft = $3,750
- Installation cost of borehole = $50/linear ft
- Length of borehole installation = 50 ft
- Oversight (assumption) = 1 day = 8 hours ($56/h).

Other costs associated with installing replacement boreholes are included on the cost estimate sheets. These items include, but are not limited to, mobilization of a drill rig, decontamination of a drill rig, and handling of IDW.

Reporting: Annual and periodic activities will be recorded in an annual report. The report will contain descriptions of activities that occurred during the year. Reports will contain all appropriate/required backup and material purchase information. The cost for the annual reports is based on the following assumption:

- Annual reports = \$10,000/report.

Site Reviews: The cost associated with site reviews is an operation and maintenance cost. This cost will be incurred every 5 years as long as the alternative is being used. Site reviews will be conducted to assess site conditions, evaluate the selected alternative, and determine whether additional steps toward remediation are required. The cost for the 5-year site reviews is based on the following assumption:

- 5-year site review = \$20,000/review.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate effectiveness of the remedy on groundwater quality. Refer to Section F3.1.4.

F3.2.7 Representative Waste Site 207-A South Retention Basin

Institutional Controls Implementation: Preparing and implementing institutional controls is a capital cost and includes office or administrative costs to implement deed restrictions, land-use restrictions, and groundwater-use restrictions. Costs presented in the cost estimates are based on the following:

- Time to produce institutional controls = 200 hours (assumption)
- Labor rate = \$56/h (assumption).

Site Inspection and Surveillance: The cost associated with site inspection and surveillance is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. The activities performed under site inspection and surveillance include radiation surveys of surface soil and physical site inspection. Activities may include control of deeply burrowing animals and deep-rooted plants by using herbicide or by physical removal (cost for these items is not included).

Site radiation surveys: For costing purposes, sites 1 acre or smaller are assumed to cost \$8,712 for every surveying event. An additional \$1,000 will be required for site radiation surveys for every additional 5,000 ft^2 of site area larger than 1 acre.

- Area of representative site = 12,635 ft^2 (see Table F-1) = minimum 1 acre
- Radiation surveys of surface soil = \$8,712/event (\$1,000/5,000 ft^2).

Physical site inspection: For costing purposes, sites 1 acre (43,560 ft^2) or smaller are assumed to require a team of two inspectors to perform the activities associated with site inspection and surveillance. Additional crew time will be needed for site inspection and surveillance for site areas larger than 1 acre.

The cost for site inspection and surveillance is based on the following.

- Area of representative site = 12,635 ft^2 (see Table F-1)
- Cost to complete inspection = minimum 1 acre = \$781/acre.

Existing Cover Maintenance: The cost associated with existing cover maintenance is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. Because cover maintenance is performed annually, including costs for replacing all or large portions of the existing cover at specified intervals is unnecessary. Rather, cover maintenance is assumed to include replacing cover soils over 10 percent of the area to a depth of 2 ft. The soil used to repair the existing cover is a silt loam and pea gravel mixture. The pea gravel is used to make the soil resistant to wind erosion.

For costing purposes, it is assumed that the silt loam can be acquired for no material cost from an onsite borrow source (Area C) and that pea gravel must be purchased at an offsite location. Both materials (silt loam and pea gravel) must be mixed before being transported and placed at the site. It is assumed that periodically a large volume of silt and pea gravel will be mixed and stockpiled by a subcontractor at Area C. This mixture will be used for the repair of barrier surfaces. The material and transportation cost of pea gravel, excavation and hauling of the silt, and the blending and stockpiling is estimated at \$8.95/yd^3 for the mixture in stockpile at Area C.

For representative sites with areas larger than 100,000 ft^2, it is assumed for transporting the silt loam/pea gravel mixture to the waste site, that one front-end loader with operator will load dump trucks for transportation to the site. To transport the silt loam to the site, it is assumed that five dump trucks and five drivers will be used and each dump truck will make two trips an hour to the site carrying 12 yd^3 per trip. For representative sites less than 100,000 ft^2, one front-end loader with one operator will directly load two dump trucks making two trips an hour to the site.

Once the material is at the waste site, it is assumed that the silt loam/pea gravel mixture will be unloaded at the repair area and spread with an LPG dozer over the area. A 3,000-gal water truck will be used for dust control during the spreading process. For sites with areas less than 100,000 ft^2, one LPG dozer will be used. For sites with areas larger than 100,000 ft^2, two LPG dozers will be used. Once the silt loam and pea gravel mixture is in place, these areas will be revegetated. It is assumed that a revegetation crew can reseed 1 acre in an hour.

In addition to the transportation, spreading, and revegetation costs, it is assumed that FH will have a site engineer onsite during cover maintenance activities to provide oversight.

For planning purposes, the repair of a 1-acre waste site will require 323 yd^3 of silt loam/pea gravel mixture, 3 hours to load and transport, 4 hours to spread, and 1 hour to reseed. With supervisory oversight, the cost per acre is \$5,728. Waste sites less than 1 acre are assumed to cost the same as 1 acre.

The cover maintenance costs are calculated as follows:

- Cover maintenance (footprint of cover)
  - Area of cover system = 0.29 acres = minimum 1 acre
  - Area requiring repair (10% of total area) = 484 yd^2
  - Volume of cover repair (2 ft) = 323 yd^3
  - Oversight = 3 hours.

Monitoring for Natural Attenuation: The cost associated with natural attenuation monitoring is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. The cost for natural attenuation monitoring includes spectral gamma logging of vadose zone boreholes.

Vadose zone monitoring costs assume spectral gamma logging of one borehole per waste site to a depth of 50 ft once every 5 years. The service life of a vadose zone borehole is assumed to be 30 years. Therefore, every 30 years a replacement borehole will be drilled. Costs are based on the following:

- Unit cost for vadose zone monitoring = $75/ft of borehole
- Length of borehole drilling = 50 ft
- Cost of vadose zone monitoring = $75/ft x 50 ft = $3,750
- Installation cost of borehole = $50/linear ft
- Length of borehole installation = 50 ft
- Oversight (assumption) = 1 day = 8 hours ($56/h).

Other costs associated with installing replacement boreholes are included on the cost estimate sheets. These items include, but are not limited to, mobilization of a drill rig, decontamination of a drill rig, and handling of IDW.

Reporting: Annual and periodic activities will be recorded in an annual report. The report will contain descriptions of activities that occurred during the year. Reports will contain all appropriate/required backup and material purchase information. The cost for the annual reports is based on the following assumption:

- Annual reports = $10,000/report.

Site Reviews: The cost associated with site reviews is an operation and maintenance cost. This cost will be incurred every 5 years as long as the alternative is being used. Site reviews will be conducted to assess site conditions, evaluate the selected alternative, and determine whether additional steps toward remediation are required. The cost for the 5-year site reviews is based on the following assumption:

- 5-year site review = $20,000/review.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate effectiveness of the remedy on groundwater quality. Refer to Section F3.1.4.

F3.2.8 Representative Waste Site 216-A-37-1 Crib

Institutional Controls Implementation: Preparing and implementing institutional controls is a capital cost and includes office or administrative costs to implement deed restrictions, land-use restrictions, and groundwater-use restrictions. Costs presented in the cost estimates are based on the following:

- Time to produce institutional controls = 200 hours (assumption)
- Labor rate = $56/h (assumption).

Site Inspection and Surveillance: The cost associated with site inspection and surveillance is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. The activities performed under site inspection and surveillance include radiation surveys of surface soil and physical site inspection. Activities may include control of deeply burrowing animals and deep-rooted plants by using herbicide or by physical removal (cost for these items is not included).

<u>Site radiation surveys</u>: For costing purposes, sites 1 acre or smaller are assumed to cost $8,712 for every surveying event. An additional $1,000 will be required for site radiation surveys for every additional 5,000 ft^2 of site area larger than 1 acre.

- Area of representative site = 7,000 ft^2 (see Table F-1)
  = minimum 1 acre
- Radiation surveys of surface soil = $8,712/event ($1,000/5,000 ft^2).

<u>Physical site inspection</u>: For costing purposes, sites 1 acre (43,560 ft^2) or smaller are assumed to require a team of two inspectors to perform the activities associated with site inspection and surveillance. Additional crew time will be needed for site inspection and surveillance for site areas larger than 1 acre.

The cost for site inspection and surveillance is based on the following.

- Area of representative site = 7,000 ft^2 (see Table F-1)
- Cost to complete inspection = minimum 1 acre
  = $781/acre.

Existing Cover Maintenance: The cost associated with existing cover maintenance is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. Because cover maintenance is performed annually, including costs for replacing all or large portions of the existing cover at specified intervals is unnecessary. Rather, cover maintenance is assumed to include replacing cover soils over 10 percent of the area to a depth of 2 ft. The soil used to repair the existing cover is a silt loam and pea gravel mixture. The pea gravel is used to make the soil resistant to wind erosion.

For costing purposes, it is assumed that the silt loam can be acquired for no material cost from an onsite borrow source (Area C) and that pea gravel must be purchased at an offsite location. Both materials (silt loam and pea gravel) must be mixed before being transported and placed at the site. It is assumed that periodically a large volume of silt and pea gravel will be mixed and stockpiled by a subcontractor at Area C. This mixture will be used for the repair of barrier surfaces. The material and transportation cost of pea gravel, excavation and hauling of the silt, and the blending and stockpiling is estimated at \$8.95/yd^3 for the mixture in stockpile at Area C.

For representative sites with areas larger than 100,000 ft^2, it is assumed for transporting the silt loam/pea gravel mixture to the waste site, that one front-end loader with operator will load dump trucks for transportation to the site. To transport the silt loam to the site, it is assumed that five dump trucks and five drivers will be used and each dump truck will make two trips an hour to the site carrying 12 yd^3 per trip. For representative sites less than 100,000 ft^2, one front-end loader with one operator will directly load two dump trucks making two trips an hour to the site.

Once the material is at the waste site, it is assumed that the silt loam/pea gravel mixture will be unloaded at the repair area and spread with an LPG dozer over the area. A 3,000-gal water truck will be used for dust control during the spreading process. For sites with areas less than 100,000 ft^2, one LPG dozer will be used. For sites with areas larger than 100,000 ft^2, two LPG dozers will be used. Once the silt loam and pea gravel mixture is in place, these areas will be revegetated. It is assumed that a revegetation crew can reseed 1 acre in an hour.

In addition to the transportation, spreading, and revegetation costs, it is assumed that FH will have a site engineer onsite during cover maintenance activities to provide oversight.

For planning purposes, the repair of a 1-acre waste site will require 323 yd^3 of silt loam/pea gravel mixture, 3 hours to load and transport, 4 hours to spread, and 1 hour to reseed. With supervisory oversight, the cost per acre is \$5,728. Waste sites less than 1 acre are assumed to cost the same as 1 acre.

The cover maintenance costs are calculated as follows:

- Cover maintenance (footprint of cover)
  - Area of cover system = 0.16 acres
    = minimum 1 acre
  - Area requiring repair (10% of total area) = 484 yd^2
  - Volume of cover repair (2 ft) = 323 yd^3
  - Oversight = 3 hours.

Monitoring for Natural Attenuation: The cost associated with natural attenuation monitoring is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. The cost for natural attenuation monitoring includes spectral gamma logging of vadose zone boreholes.

Vadose zone monitoring costs assume spectral gamma logging of one borehole per waste site to a depth of 50 ft once every 5 years. The service life of a vadose zone borehole is assumed to be 30 years. Therefore, every 30 years a replacement borehole will be drilled. Costs are based on the following:

- Unit cost for vadose zone monitoring = \$75/ft of borehole
- Length of borehole drilling = 50 ft

- Cost of vadose zone monitoring = \$75/ft x 50 ft = \$3,750
- Installation cost of borehole = \$50/linear ft
- Length of borehole installation = 50 ft
- Oversight (assumption) = 1 day = 8 hours (\$56/h).

Other costs associated with installing replacement boreholes are included on the cost estimate sheets. These items include, but are not limited to, mobilization of a drill rig, decontamination of a drill rig, and handling of IDW.

Reporting: Annual and periodic activities will be recorded in an annual report. The report will contain descriptions of activities that occurred during the year. Reports will contain all appropriate/required backup and material purchase information. The cost for the annual reports is based on the following assumption:

- Annual reports = \$10,000/report.

Site Reviews: The cost associated with site reviews is an operation and maintenance cost. This cost will be incurred every 5 years as long as the alternative is being used. Site reviews will be conducted to assess site conditions, evaluate the selected alternative, and determine whether additional steps toward remediation are required. The cost for the 5-year site reviews is based on the following assumption:

- 5-year site review = \$20,000/review.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate effectiveness of the remedy on groundwater quality. Refer to Section F3.1.4.

F3.3 ALTERNATIVE 3 – REMOVAL, TREATMENT, AND DISPOSAL

Trenches and cribs are excavated to the required depth and contaminated material is removed to the Environmental Restoration Disposal Facility (ERDF) for disposal. The sites are then remediated. Excavation depth and mixing requirements are different for each group of trenches and cribs.

F3.3.1 General Assumptions

The general assumptions for Alternative 3 are as follows.

F3.3.1.1 Fieldwork such as mobilization/demobilization, excavation, backfill, revegetation, and some of the post-construction work will be contracted to an FP contractor. The project management, radiological control technician (RCT) support, sampling, and safety oversight will be performed by FH. The waste disposal work involved with hauling from the site to ERDF and ERDF dumping cost/fees will be performed by the environmental restoration contractor responsible for ERDF.

F3.3.1.2 Mobilization and startup include site training; mobilization of equipment and personnel; installation of temporary construction fences; construction of staging/container storage areas and access roads; and setting up office, change, and storage trailers with utilities, truck scales, temporary survey buildings, and decontamination areas.

F3.3.1.3 The excavation sites will have contaminated waste removed. The sides of the excavation will be sloped at 1.5:1 to the bottom of the excavation, except for those sites that originally were constructed using 2:1 slopes. During the removal process, heavy equipment will be kept out of the excavation site. For sites that have a planned excavation depth in excess of 100 ft, see Section F3.3.1.16 for the general assumptions for those sites.

F3.3.1.4 For excavation sites, overburden will be removed with a 2- to 3-yd^3 excavator and two haul trucks. The soil will be stockpiled near the waste site. A highway truck with a water tank trailer is used to control dust during this activity. The production rate for one crew is 127 yd^3/h.

F3.3.1.5 Contaminated waste will be excavated using a 2- to 3-yd^3 hydraulic crawler excavator. The contaminated soil will be directly placed into lined ERDF containers and hauled from the excavation site. A highway truck with a water tank trailer is used to control dust during this activity. Depending on the volume of waste to move, one to four crews can be working at a site. Crew labor consists of one operator, one laborer, and one truck driver. The production rate for one crew is 55 yd^3/h. An FH RCT supports the work at 1½ hours per excavation crew hour.

F3.3.1.6 Air sampling will be performed during the excavation of contaminated soil. A minimum of two samples will be taken per day. The planning cost per sample is $520. The sampling crew consists of one sampler and one RCT.

F3.3.1.7 Soil samples will be taken of the overburden, from ERDF containers, and for verification at the completion of the excavation. The soil-sampling cost developed is as follows:

- Noncontaminated soil sampling
  - Maximum of 6 samples or 1 sample per cubic yard, whichever is less
  - Quality assurance (QA) sample required: 1
  - The planning cost per sample is $1,262/sample.
  - The soil being sampled is the overburden that is uncontaminated and will not be removed from the site.

- Sampling required for waste going to ERDF:
  - One sample is required for every 70 containers.
  - There will be a minimum of six samples per site.
  - QA samples required: a minimum of 1 or 5 percent of total ERDF samples, whichever is greater
  - The planning cost per sample is $452/sample.
- Pre-verification process sampling
  - One sample will be required per 2,500 m^2 (50 m x 50 m) (26,899 ft^2).
  - There will be a minimum of six samples per site.
  - QA samples required: a minimum of 2 or 5 percent of total the samples, whichever is greater
  - The planning cost per sample is $2,227/sample.
  - These samples are the preliminary samples needed to see if all of the required waste has been removed from a site being excavated.
  - This process is expected to happen twice during the excavation process.
  - If the samples show that the site has met the requirement, then the verification process will start.
- Verification process sampling
  - One sample will be required per 625 m^2 (25 m x 25 m) (6,724 ft^2).
  - There will be a minimum of six samples per site.
  - QA samples required: a minimum of 2 or 5 percent of total the samples, whichever is greater
  - The planning cost per sample is $7,856/sample for onsite laboratory analysis and $1,458 for offsite laboratory analysis and shipping (based on six samples being processed at one time), for a total of $9,314/sample.
  - These samples are the final samples needed to see if all of the required waste has been removed from a site being excavated.
  - This process happens once during the excavation process.

- Sampling crews
  - Verification sampling – 1 hour for each sample taken by a crew consisting of one FH RCT and a sampler technician.
  - Other sampling (air, ERDF, noncontaminated) – 1 hour for each sample taken by a crew consisting of one FH RCT and a sampler technician.

F3.3.1.8 The ERDF container handling and loading process starts with a site haul truck picking up an empty container at the staging area. The container is moved to a preparation area where laborers install a bed liner and inspected by a half-time time RCT. The haul truck and container proceed to the loading area. After loading, the liner is sealed and the container is secured by laborers. The container is moved to the survey building where a three RCTs inspect and survey the container and truck for contamination. From there, the haul truck and container are weighed on a platform scale and then driven to the storage area. The container is unloaded from the truck at the storage area. Three trucks are required to support each contaminated excavation crew.

F3.3.1.9 ERDF disposal fee, transportation, and handling costs are estimated at $980 per container. An environmental restoration contractor driver and truck/trailer will move a loaded container to ERDF and place an empty container in the staging area. The estimated costs include the rental of the containers used. For planning purposes, the capacity of an ERDF container is 11 bulk yd^3 or 12.7 loose yd^3 of contaminated waste.

F3.3.1.10 Backfilling is performed by three different operations:

- The moving of the stockpiled overburden back to the excavation site will require one crew. The equipment used by a crew is one 4- to 5-yd^3 loader and two haul trucks. Labor is one operator and two truck drivers. The production rate for one crew is 185 yd^3/h.
- The moving of borrow material to the excavation site typically is performed by one crew hauling from an onsite pit source. The equipment used by a crew is one 4- to 5-yd^3 loader, six 20-yd^3 highway truck/trailers, and one water truck. Labor is one operators and seven truck drivers. The production rate for one crew is 185 yd^3/h.
- Spreading and compaction of the backfill at the site is performed by one crew. The equipment used per crew is one 300-hp dozer and one 6,000-gal water truck/trailer. Labor consists of one operator, one truck driver, and one laborer. The production rate for one crew is 185 yd^3/h.

F3.3.1.11 Revegetation of the waste site includes planting native dry land grass using tractors with seed drills and hand broadcasting, hand planting sagebrush seedlings, and irrigation for four times in the spring or early summer. All disturbed areas, such as around the waste site, stockpile, staging areas, and access roads, will be replanted.

F3.3.1.12 The FH Project Management team consists of a part-time project manager, with a full-time field supervisor, and part-time engineering support. QA, Radiological Control, and Safety also provide oversight along with other support for contract management, and project controls. Total hours for this staff are planned at 22.5 hours per day. The duration of this work is based on total project duration.

F3.3.1.13 The FP contractor field supervisory team consists of a full-time construction manager and field supervisor, along with part-time QA, construction safety, and clerical support. Two pickup trucks are included in the cost. Total hours for this staff are planned at 21 hours per day. The duration of this work is based on total project duration.

F3.3.1.14 Demobilization includes demobilization of equipment and personnel, removing temporary construction fences, construction of staging/container storage areas, access roads, office/change/storage trailers, truck scales, temporary survey buildings, and decontamination areas.

F3.3.1.15 Contaminated retention basins or belowground concrete structures will require demolition work as part of the removal work. For some structures, there will not be any contaminated soil at the site. All basins, manholes, etc., are considered empty of any sludge or debris before demolition.

- Overburden is removed the same as for other contaminated waste site removals.
- Concrete structures are to be excavated and exposed. They then will be divided into small sections with an impact hammer, pulverizer, or crusher mounted on a hydraulic excavator. After that, the debris will be loaded into an ERDF container.
- Steel structures or tanks are to be cut up using a shear mounted on a hydraulic excavator. After that, the debris will be loaded into an ERDF container.
- The ERDF containers have a 6-in. sand bed on the bottom of the liners and bedding sand placed with the demolition debris to ensure the liners are not damaged.
- The excavation of the overburden soil, the processing of ERDF containers, sampling, backfilling, and revegetation of the excavation will be the same as described in Section F3.3 for excavation of removal, treatment, and disposal (RTD) sites.

F3.3.1.16 Deep excavation sites are sites that require more than 100 ft of excavation to reach the required remediation depth. The excavation sites will require a terraced side slope and an access road to the bottom of the excavation. A large overburden stockpile site also will be located near the excavation site. Some activities will require that more than one crew will be working at one time; however, this will depend on the size of the available work site. Mobilization, demobilization, revegetation, project management, and construction management will be the same as described above.

- The removal of the contaminated soil is handled the same as outlined in Sections F3.3.1.5 to F3.3.1.9.

- Removal of overburden and clean soil will require more and larger equipment compared to the equipment used in the work described above. The work also includes the building of a large stockpile site and pit access road. One removal crew will need three 300- to 400-hp dozers, six 40- to 44-yd^3 wheel scrapers, a 6,000-gal water tanker, and a 150-hp motor grader. The planned production rate for this crew is 1,740 yd^3/h of clean soil removed and stockpiled. Two crews will be used for the removal of approximately 80 percent of the clean soil; a single crew will complete the remaining excavation.

- After the contaminated soil has been removed, the stockpiled clean soil will be returned to the excavation site. The planned crew will use four 300- to 400-hp dozers and twelve 40-to 44-yd^3 wheel scrapers to load and move the soil to the pit area. The planned production rate is 3,480 yd^3/h.

- Contaminated material removed from the site will be replaced with borrow material from a Hanford Site pit source. The loading and hauling of borrow material will require two 7-yd^3 loaders, two 250- to 300-hp dozers, eighteen highway haul trucks with 20-yd^3 trailers, and a 6,000-gal water tanker. All the equipment is operating at the borrow site except the haul trucks. The production rate is 840 yd^3/h.

- The backfill spreading operation at the excavation site spreads the soil brought in from the clean overburden stockpile and from the borrow pit. In addition, this operation provides site access road maintenance and dust control. A single crew will use two 300-to 400-hp dozers, two 6,000-gal water tankers, and a 200- to 250-hp motor grader. Two crews will be used for the spreading of approximately 80 percent of the clean soil; a single crew will complete the remaining backfill spreading. This operation is expected to keep pace with the soil being brought in from the clean overburden stockpile and from the borrow pit.

F3.3.1.17 Deep excavations with TRU[1] waste sites are sites that require more than 100 ft of excavation to reach the required remediation depth and include the removal of a layer of TRU waste. The excavation and removal of waste that can be disposed of at ERDF is handled the same as described in Section F3.3.1.16. This includes mobilization/demobilization, removal of clean soil, backfilling the site, and other site work. The TRU-contaminated waste is expected to be within 22 to 28 ft from the ground surface. The thickness of the layer of TRU-contaminated soil is expected to be 3 ft. The length and width dimensions used to calculate the volume of TRU waste are the same as the design dimensions of the cribs. The final disposition of the TRU waste is at the Waste Isolation Pilot Plant (WIPP) storage facility.

- Excavation of TRU waste is performed inside of a portable greenhouse. This structure is sized to cover 80 by 10 ft of the excavation site along with a work area for a hydraulic excavator and container-staging site. The structure can be moved along the length of the site by rails or crane.

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[1]Waste materials contaminated with more than 100 nCi/g of transuranic materials having half-lives longer than 20 years.

- The TRU waste is placed into WIPP standard waste boxes (SWB). For planning purposes, each box is expected to handle 1.5 yd^3 of waste.
- The field crews can fill, cover, inspect, sample, radiological survey, and move two SWBs per hour. The boxes are direct loaded with a small hydraulic excavator at the waste site. The filled boxes are temporarily staged at the waste site container storage area.
- After the initial sample analysis of the waste, those SWBs determined to contain TRU waste are moved to the Central Waste Complex (CWC) for processing, head spaces sampling, nondestructive analysis, and temporary storage. The waste storage rate for TRU waste is \$37.32/ft^3.
- Ten percent of the SWBs stored at CWC are shipped to the Idaho National Engineering and Environmental Laboratory (INEEL) for further sampling and analysis, which are required before shipment to WIPP. The sampled SWBs then are returned to CWC. Six SWBs can be loaded on a truck for shipment. The planning cost for a round trip to INEEL is \$24,000 per truckload.
- After analysis of the INEEL sampling and the completion of the waste profile study, the SWBs are shipped to WIPP for storage. Six SWBs can be loaded on a truck for shipment to WIPP. The planning cost of one truck trip to WIPP is \$12,000.
- At this time, there are no handling costs or storage rates for the SWBs after arriving at WIPP.

F3.3.2 Representative Waste Site 216-A-19 Trench (Cost Tables F-8 and F-9)

The site work is estimated to take 61 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown.

- Mobilization: 10 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites
- Excavate contaminated and uncontaminated soil: 27 days
- Restore site: 14 days to backfill and revegetate the site
- Demobilize: 10 days.

Total construction duration = 61 days = 12.2 weeks = 2.9 months.

Site Description: The basis for the following information can be found in Table F-1.

- Area of contamination: 25 ft x 25 ft = 625 ft^2
- Depth of clean overburden: 0 ft below ground surface (bgs)

- Total excavated depth: 36 ft bgs
- Volume of contaminated soil to be removed: 12,545 yd^3
- Total excavated volume (2:1 side slopes): 12,545 yd^3
- Volume of clean overburden: 0 yd^3
- Volume of borrow from onsite source: 12,545 yd^3.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories.

Typical heavy equipment mobilized to and demobilized from the site is as follows:

- One large dozer
- One 2- to 3-yd^3 excavator
- One 4- to 5-yd^3 wheel loader
- Six off-highway dump trucks
- Backhoe loader
- Two farm tractors
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- One flatbed truck
- Three trucks with tilt container beds
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $5,862 to mobilize. The cost to demobilize is planned at $16,572, which includes the decontamination of the equipment included, along with moving the equipment to the storage yard. This cost includes the FP labor to clean the equipment. The FH RCT labor hours support to decontamination of the construction equipment is 40 hours, which is planned at $2,462.

Contractor personnel are given training before the start of work at the site. The cost of training is planned at $27,743. The training will meet site requirements to work at a waste site. The four typical crews were used to calculate the cost of training.

The contractor will set up or construct a temporary staging area, two office trailers, change trailer, storage container, truck scales, and survey building at a cost of $42,937. The rental cost of the trailers, scales, and utilities is included and is based on the duration of the work. Site access roads will be constructed at a cost of $8,226. Decontamination areas will be set up as part of the site mobilization at a cost of $46,349. The staging area and roads will be scarified as part of demobilization and the planning cost is $862. The decontamination areas will be removed at a planning cost of $21,020. The office trailers, truck scales, and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site is $3,710 to construct and $862 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $1,730 and is based on the area of the waste site.

Monitoring and Sampling: FH will perform all sampling required.

Soil sampling (noncontaminated soil, ERDF certification, pre-verification, verification samples). See Section F3.3.1 for sampling rate and process.

- Noncontaminated samples (includes QA samples): 1 sample
- ERDF certification samples (includes QA samples): 18 samples
- Pre-verification samples (includes QA samples): 16 samples
- Verification samples (includes QA samples): 9 samples
- Soil-sampling cost: $147,939.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 76 samples
- Quarterly environmental permit samples: 4 samples
- Air-sampling cost: $47,760.

Field sampling FH crew support:

- Sampling crew: 112 hours
- Sampling crew cost: $12,225.

Site Work: This activity covers the backfilling of the site with the overburden soil and soil hauled from an onsite borrow source. This activity has three items of work: loading and hauling the overburden, loading and hauling the borrow soil, and spreading backfill at the site. Dust control is included in this work. See Section F3.3.1 for crews and production rates. For this site, four crews will be used due to the amount of overburden and borrow soil to be hauled and spread. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.

- Load/haul overburden volume: 0 yd^3
- Planning cost to load/haul overburden: $0
- Load/haul borrow soil volume: 12,545 yd^3
- Planning cost to load/haul borrow soil: $83,973
- Spread backfill/compaction volume: 12,545 yd^3
- Planning cost to spread backfill/compaction: $31,378
- Miscellaneous cleanup duration: 15 weeks
- Planning cost for miscellaneous cleanup: $5,815.

Site revegetation is part of site restoration. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site, overburden stockpile, staging areas, and access roads.

- Total area to be revegetated: 5 acres
- Planning cost for reseeding: $5,764
- Planning cost for planting sagebrush: $6,425
- Planning cost for irrigation: $30,090.

Soil Excavation:

- Excavation: The work activities covered by Excavation include stripping and stockpiling overburden soil, and excavation of contaminated soil. The contaminated soil will be placed directly into the ERDF containers. The moving of the containers from the excavation site and the processing of the containers are covered in the container loading and handling process description (see below). Dust suppression is included in each activity. A description of how the work is performed is presented in Section F3.3.1. For this site, four crews will be used due to the amount of overburden and contaminated soil to be removed.

  - Overburden soil removed and stockpiled: 0 yd^3
  - Planning cost to remove overburden: $0
  - Excavation of contaminated soil: 12,545 yd^3
  - Planning cost to excavate contaminated soil: $74,217
  - RCT support for soil excavation: 187 hours
  - RCT excavation support cost: $17,267
  - FH industrial safety support: 216 hours
  - FH industrial safety cost: $14,733.

- Container loading and handling process: This activity involves installing liners in containers, hauling the containers to a survey area, weighing, and unloading at a temporary storage area. See Section F3.3.1 for details of how the work is performed. For this site, four crews will be used due to the amount of contaminated soil to be handled.

  - Number of ERDF containers hauled, weighed, and processed: 1,122
  - Planning cost for hauling and securing the containers: $102,016
  - Planning cost for preparing containers for loading: $99,638
  - Planning cost for weighing and storing containers: $51,798
  - RCT crew support for queue operations survey: 187 hours
  - RCT support for queue operations planning cost: $5,755
  - RCT support for container radiation surveying: 561 hours
  - RCT support for container radiation surveying planning cost: $34,535.

- ERDF transportation and disposal: The planning cost for disposal and transportation is $980 per container without overhead charges. This cost includes the disposal fee, the transportation cost from the wastes site staging area to ERDF, and the replacement of the loaded container with an empty container at the staging area.

- Total number of containers required: 1,122
- Cost of containers: $1,265,562.

Construction Staff: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final Deactivation and Decommissioning (D&D) Report includes the cost of the contractor to turn over submittals required to close out the work. This activity is considered a lump sum cost to the project.

- Duration of project: 61 days
- Planning cost for field management: $163,871
- Planning cost for final D&D report: $8,920.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.3.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. This activity is a lump sum cost to the project. The final site survey by the FH survey team is part of the as-built process and is based on the area of the waste site.

- Duration of project management: 61 days
- Project management cost: $104,055
- Planning cost for final D&D report: $2,019
- Area of final site survey: 2 acres
- Planning cost for final site survey: $817.

Annual Cost: No annual costs are associated with Alternative 3. No site monitoring is required because all of the contaminated waste will be removed.

F3.3.3 Representative Waste Site 216-B-12 Crib (Cost Tables F-8 and F-9)

The site work is estimated to take 481 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown.

- Mobilization: 15 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites

- Excavate contaminated and uncontaminated soil: 219 days

- Restore site: 231 days to backfill and revegetate the site

- Demobilize: 15 days.

Total construction duration = 481 days = 96 weeks = 23 months.

Site Description: The basis for the following information can be found in Table F-1.

- Area of contamination: 160 ft x 50 ft = 8,000 ft^2
- Depth of clean overburden: 14 ft bgs
- Total excavated depth: 191.5 ft bgs
- Volume of contaminated soil to be removed: 52,593 yd^3
- Total excavated volume (1.5:1 side slopes): 4,507,268 yd^3
- Volume of clean overburden: 4,454,675 yd^3
- Volume of borrow from onsite source: 52,593 yd^3.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories.

Typical heavy equipment mobilized to and demobilized from the site is as follows:

- Six large dozers, 300 to 400 hp
- Twelve 40- to 44-yd^3 scrapers
- One 2- to 3-yd^3 excavator
- Two 7-yd^3 loaders
- Backhoe loader
- Two farm tractors
- Two motor graders
- Eighteen semi-tractors and 20-yd^3 bottom dump trailers
- Four 4,000- to 6,000-gal water trucks
- One flatbed truck
- Three trucks with tilt container beds
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $103,116 to mobilize. The cost to demobilize is planned at $103,116, which includes the decontamination of the equipment included, along with moving the equipment to the storage yard. This cost includes the FP labor to clean the equipment. The FH RCT labor hours support to decontamination of the construction equipment is 40 hours, which is planned at $2,462.

Contractor personnel are given training before the start of work at the site. The cost of training is planned at $103,116. The training will meet site requirements to work at a waste site. The four typical crews were used to calculate the cost of training.

The contractor will set up or construct a temporary staging area, two office trailers, change trailer, storage container, truck scales, and survey building at a cost of $260,675. The rental cost of the trailers, scales, and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $108,814. Decontamination areas will be set up as part of the site mobilization at a cost of $12,128. The staging area and roads will be scarified as part of demobilization and the planning cost is $585. The decontamination areas also will be removed at a planning cost of $5,801. The office trailers, truck scales, and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site is $47,258 to construct and $855 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $39,503 and is based on the area of the waste site.

Monitoring and Sampling: FH will perform all sampling required.

Soil sampling (noncontaminated soil, ERDF certification, pre-verification, verification samples). See Section F3.3.1 for sampling rate and process.

- Noncontaminated samples (includes QA samples): 7 samples
- ERDF certification samples (includes QA samples): 69 samples
- Pre-verification samples (includes QA samples): 53 samples
- Verification samples (includes QA samples): 105 samples
- Soil-sampling cost: $1,304,267.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 481 samples
- Quarterly environmental permit samples: 18 samples
- Air-sampling cost: $297,908.

Field sampling FH crew support:

- Sampling crew: 1,782 hours
- Sampling crew cost: $104,307.

Site Work: This activity covers the backfilling of the site with the overburden soil and soil hauled from an onsite borrow source. This activity has three items of work: loading and hauling the overburden, loading and hauling the borrow soil, and spreading backfill at the site. Dust control is included in this work. See Section F3.3.1 for crews and production rates. For this site, four crews will be used due to the amount of overburden and borrow soil to be hauled and spread. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.

- Load/haul overburden volume: 4,454,675 yd^3
- Planning cost to load/haul overburden: $6,600,219
- Load/haul borrow soil volume: 52,593 yd^3
- Planning cost to load/haul borrow soil: $183,121
- Spread backfill/compaction volume: 4,507,268 yd^3
- Planning cost to spread backfill/compaction: $2,241,556

- Miscellaneous cleanup duration: 96 weeks
- Planning cost for miscellaneous cleanup: $11,708.

Site revegetation is part of site restoration. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site, overburden stockpile, staging areas, and access roads.

- Total area to be revegetated: 61 acres
- Planning cost for reseeding: $43,889
- Planning cost for planting sagebrush: $55,837
- Planning cost for irrigation: $341,351.

Soil Excavation:

- Excavation: The work activities covered by Excavation include stripping and stockpiling overburden soil, and excavation of contaminated soil. The contaminated soil will be placed directly into the ERDF containers. The moving of the containers from the excavation site and the processing of the containers are covered in the container loading and handling process description (see below). Dust suppression is included in each activity. A description of how the work is performed is presented in Section F3.3.1. For this site, four crews will be used due to the amount of overburden and contaminated soil to be removed.

  - Overburden soil removed and stockpiled: 4,454,675 yd^3
  - Planning cost to remove overburden: $7,728,998
  - Excavation of contaminated soil: 52,593 yd^3
  - Planning cost to excavate contaminated soil: $382,212
  - RCT support for soil excavation: 6,029 hours
  - RCT excavation support cost: $367,190
  - FH industrial safety support: 1,093 hours
  - FH industrial safety cost: $64,839.

- Container loading and handling process: This activity involves installing liners in containers, hauling the containers to a survey area, weighing, and unloading at a temporary storage area. See Section F3.3.1 for details on how the work is performed. For this site, four crews will be used due to the amount of contaminated soil to be handled.

  - Number of ERDF containers hauled, weighed, and processed: 4,782
  - Planning cost for hauling and securing the containers: $378,901
  - Planning cost for preparing containers for loading: $370,496
  - Planning cost for weighing and storing containers: $193,795
  - RCT support for queue operations survey: 547 hours
  - RCT support for queue operations planning cost: $33,643
  - RCT support for container radiation surveying: 3,279 hours
  - RCT support for container radiation surveying planning cost: $201,858.

- ERDF transportation and disposal: The planning cost for disposal and transportation is $980 per container without overhead charges. This cost includes the disposal fee, the transportation cost from the wastes site staging area to ERDF, and the replacement of the loaded container with an empty container at the staging area.
  - Total number of containers required: 4,782
  - Cost of containers: $6,810,212.

Construction Staff: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. This activity is considered a lump sum cost to the project.

- Duration of project: 481 days
- Planning cost for field management: $2,206,057
- Planning cost for final D&D report: $8,920.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.3.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. This activity is considered a lump sum cost to the project. The final site survey by the FH survey team is part of the as-built process and is based on the area of the waste site.

- Duration of project management: 481 days
- Project management cost: $862,154
- Planning cost for final D&D report: $2,019.

Annual Cost: No annual costs are associated with Alternative 3. No site monitoring is required because all of the contaminated waste will be removed.

F3.3.4 Representative Waste Site 216-S-7 Crib (Cost Tables F-8 and F-9)

The site work is estimated to take 613 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown.

- Mobilization: 15 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites

- Excavate contaminated and uncontaminated soil: 284 days

- Restore site: 298 days to backfill and revegetate the site
- Demobilize: 15 days.

Total construction duration = 613 days = 123 weeks = 30 months.

Site Description: The basis for the following information can be found in Table F-1.

- Area of contamination: 100 ft x 50 ft = 5, 000 ft^2
- Depth of clean overburden: 15 ft bgs
- Total excavated depth: 225.5 ft bgs
- Volume of contaminated soil to be removed: 38,981 yd^3
- Total excavated volume (1.5:1 side slopes): 5,813,898 yd^3
- Volume of clean overburden: 5,774,916 yd^3
- Volume of borrow from onsite source: 38,981 yd^3.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories.

Typical heavy equipment mobilized to and demobilized from the site is as follows:

- Six large dozers, 300 to 400 hp
- Twelve 40- to 44-yd^3 scrapers
- One 2- to 3-yd^3 excavator
- Two 7-yd^3 loaders
- Backhoe loader
- Two farm tractors
- Two motor graders
- Eighteen semi-tractors and 20-yd^3 bottom dump trailers
- Four 4,000- to 6,000-gal water trucks
- One flatbed truck
- Three trucks with tilt container beds
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $103,116 to mobilize. The cost to demobilize is planned at $103,116, which also includes the decontamination of the equipment included, along with moving the equipment to the storage yard.

Contractor personnel are given training before the start of work at the site. The cost of training is planned at $103,116. The training will meet site requirements to work at a waste site. The four typical crews were used to calculate the cost of training.

The contractor will set up or construct a temporary staging area, two office trailers, change trailer, storage container, truck scales, and survey building at a cost of $260,675. The rental cost of the trailers, scales, and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $108,814. Decontamination areas will be set up as part of the site mobilization at a cost of $12,128. The staging area and roads will be scarified as part of demobilization and the planning cost is $585. The decontamination areas also will be removed at a planning cost of $5,801. The office trailers, truck scales, and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site is $46,160 to construct and $6,722 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $46,475 and is based on the area of the waste site.

Monitoring and Sampling: FH will perform all sampling required.

Soil sampling (noncontaminated soil, ERDF certification, pre-verification, verification samples). See Section F3.3.1 for sampling rate and process.

- Noncontaminated samples (includes QA samples): 7 samples
- ERDF certification samples (includes QA samples): 51 samples
- Pre-verification samples (includes QA samples): 65 samples
- Verification samples (includes QA samples): 129 samples
- Soil-sampling cost: $1,582,250.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 613 samples
- Quarterly environmental permit samples: 22 samples
- Air-sampling cost: $379,102.

Field sampling FH crew support:

- Sampling crew: 1,724 hours
- Sampling crew cost: $101,189.

Site Work: This activity covers the backfilling of the site with the overburden soil and soil hauled from an onsite borrow source. This activity has three items of work: loading and hauling the overburden, loading and hauling the borrow soil, and spreading backfill at the site. Dust control is included in this work. See Section F3.3.1 for crews and production rates. For this site, four crews will be used due to the amount of overburden and borrow soil to be hauled and spread. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.

- Load/haul overburden volume: 5,774,916 yd^3
- Planning cost to load/haul overburden: $8,556,340
- Load/haul borrow soil volume: 38,981 yd^3
- Planning cost to load/haul borrow soil: $135,726
- Spread backfill/compaction volume: 5,813,898 yd^3
- Planning cost to spread backfill/compaction: $2,891,370

- Miscellaneous cleanup duration: 123 weeks
- Planning cost for miscellaneous cleanup: $15,001.

Site revegetation is part of site restoration. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site, overburden stockpile, staging areas, and access roads.

- Total area to be revegetated: 70 acres
- Planning cost for reseeding: $50,364
- Planning cost for planting sagebrush: $64,075
- Planning cost for irrigation: $391,714.

Soil Excavation:

- Excavation: The work activities covered by Excavation include stripping and stockpiling overburden soil, and excavation of contaminated soil. The contaminated soil will be placed directly into the ERDF containers. The moving of the containers from the excavation site and the processing of the containers are covered in the container loading and handling process description (see below). Dust suppression is included in each activity. A description of how the work is performed is presented in Section F3.3.1. For this site, four crews will be used due to the amount of overburden and contaminated soil to be removed.
  - Overburden soil removed and stockpiled: 5,774,916 yd^3
  - Planning cost to remove overburden: $10,019,657
  - Excavation of contaminated soil: 38,981 yd^3
  - Planning cost to excavate contaminated soil: $283,289
  - RCT support for soil excavation: 6,908 hours
  - RCT excavation support cost: $420,137
  - FH industrial safety support: 811 hours
  - FH industrial safety cost: $48,110.
- Container loading and handling process: This activity involves installing liners in containers, hauling the containers to a survey area, weighing, and unloading at a temporary storage area. See Section F3.3.1 for details of how the work is performed. For this site, four crews will be used due to the amount of contaminated soil to be handled.
  - Number of ERDF containers hauled, weighed, and processed: 3,544
  - Planning cost for hauling and securing the containers: $48,110
  - Planning cost for preparing containers for loading: $280,834
  - Planning cost for weighing and storing containers: $274,744
  - RCT support for queue operations survey: 406 hours
  - RCT support for queue operations planning cost: $24,963
  - RCT support for container radiation surveying: 2,433 hours
  - RCT support for container radiation surveying planning cost: $149,778.

- ERDF transportation and disposal: The planning cost for disposal and transportation is $980 per container without overhead charges. This cost includes the disposal fee, the transportation cost from the wastes site staging area to ERDF, and the replacement of the loaded container with an empty container at the staging area.
  - Total number of containers required: 3,544
  - Cost of containers: $5,048,167.

Construction Staff: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. This activity is considered a lump sum cost to the project.

- Duration of project: 613 days
- Planning cost for field management: $2,811,462
- Planning cost for final D&D report: $8,920.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.3.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. This activity is considered a lump sum cost to the project. The final site survey by the FH survey team is part of the as-built process and is based on the area of the waste site.

- Duration of project management: 613 days
- Project management cost: $1,098,753
- Planning cost for final D&D report: $2,019.

Annual Cost: No annual costs are associated with Alternative 3. No site monitoring is required because all of the contaminated waste will be removed.

F3.3.5 Representative Waste Site 216-A-10 Crib (Cost Tables F-8 and F-9)

The site work is estimated to take 291 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown.

- Mobilization: 10 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites

- Excavate contaminated and uncontaminated soil: 171 days

- Restore site: 100 days to backfill and revegetate the site

- Demobilize: 10 days.

Total construction duration = 291 days = 58.2 weeks = 13.8 months.

Site Description: The basis for the following information can be found in Table F-1.

- Area of contamination: 275 ft x 45 ft = 12,375 ft^2
- Depth of clean overburden: 30 ft bgs
- Total excavated depth: 62.5 ft bgs
- Volume of contaminated soil to be removed: 36,534 yd^3
- Total excavated volume (1.5:1 side slopes): 118,435 yd^3
- Volume of clean overburden: 81,901 yd^3
- Volume of borrow from onsite source: 36,534 yd^3.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories.

Typical heavy equipment mobilized to and demobilized from the site is as follows:

- One large dozer
- One 2- to 3-yd^3 excavator
- One 4- to 5-yd^3 wheel loader
- Six off-highway dump trucks
- Backhoe loader
- Two farm tractors
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- One flatbed truck
- Three trucks with tilt container beds
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $5,862 to mobilize. The cost to demobilize is planned at $16,572, which also includes the decontamination of the equipment included, along with moving the equipment to the storage yard. This includes the FP labor to clean the equipment. The FH RCT labor hours support to decontamination of the construction equipment is 40 hours, which is planned at $2,462.

Contractor personnel are given training before the start of work at the site. The cost of training is planned at $27,743. The training will meet site requirements to work at a waste site. The four typical crews were used to calculate the cost of training.

The contractor will set up or construct a temporary staging area, two office trailers, change trailer, storage container, truck scales, and survey building at a cost of $97,277. The rental cost of the trailers, scales, and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $8,226. Decontamination areas will be set up as part of the site mobilization at a cost of $48,645. The staging area and roads will be scarified as part of demobilization and the planning cost is $862. The decontamination areas also will be removed at a planning cost of $21,020. The office trailers, truck scales, and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site is $6,172 to construct and $1,222 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $4,326 and is based on the area of the waste site.

Monitoring and Sampling: FH will perform all sampling required.

Soil sampling (noncontaminated soil, ERDF certification, pre-verification, verification samples). See Section F3.3.1 for sampling rate and process.

- Noncontaminated samples (includes QA samples): 7 samples
- ERDF certification samples (includes QA samples): 50 samples
- Pre-verification samples (includes QA samples): 16 samples
- Verification samples (includes QA samples): 23 samples
- Soil-sampling cost: $322,946.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 536 samples
- Quarterly environmental permit samples: 12 samples
- Air-sampling cost: $327,162.

Field sampling FH crew support:

- Sampling crew: 605 hours
- Sampling crew cost: $71,264.

Site Work: This activity covers the backfilling of the site with the overburden soil and soil hauled from an onsite borrow source. This activity has three items of work: loading and hauling the overburden, loading and hauling the borrow soil, and spreading backfill at the site. Dust control is included in this work. See Section F3.3.1 for crews and production rates. For this site, four crews will be used due to the amount of overburden and borrow soil to be hauled and spread. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.

- Load/haul overburden volume: 81,901 yd^3
- Planning cost to load/haul overburden: $199,457
- Load/haul borrow soil volume: 36,534 yd^3
- Planning cost to load/haul borrow soil: $244,536
- Spread backfill/compaction volume: 118,435 yd^3
- Planning cost to spread backfill/compaction: $296,215

- Miscellaneous cleanup duration: 70 weeks
- Planning cost for miscellaneous cleanup: $27,139.

Site revegetation is part of site restoration. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site, overburden stockpile, staging areas, and access roads.

- Total area to be revegetated: 7 acres
- Planning cost for reseeding: $8,070
- Planning cost for planting sagebrush: $8,995
- Planning cost for irrigation: $42,127.

Soil Excavation:

- Excavation: The work activities covered by Excavation include stripping and stockpiling overburden soil, and excavation of contaminated soil. The contaminated soil will be placed directly into the ERDF containers. The moving of the containers from the excavation site and the processing of the containers are covered in the container loading and handling process description (see below). Dust suppression is included in each activity. A description of how the work is performed is presented in Section F3.3.1. For this site, four crews will be used due to the amount of overburden and contaminated soil to be removed.

  - Overburden soil removed and stockpiled: 81,901 yd^3
  - Planning cost to remove overburden: $403,844
  - Excavation of contaminated soil: 36,534 yd^3
  - Planning cost to excavate contaminated soil: $216,123
  - RCT support for soil excavation: 1,191 hours
  - RCT excavation support cost: $109,978
  - FH industrial safety support: 1,368 hours
  - FH industrial safety cost: $93,314.

- Container loading and handling process: This activity involves installing liners in containers, hauling the containers to a survey area, weighing, and unloading at a temporary storage area. See Section F3.3.1 for details of how the work is performed. For this site, four crews will be used due to the amount of contaminated soil to be handled.

  - Number of ERDF containers hauled, weighed, and processed: 3,265
  - Planning cost for hauling and securing the containers: $297,009
  - Planning cost for preparing containers for loading: $150,732
  - Planning cost for weighing and storing containers: $289,946
  - RCT support for queue operations survey: 545 hours
  - RCT support for queue operations planning cost: $16,775
  - RCT support for container radiation surveying: 1,635 hours
  - RCT support for container radiation surveying planning cost: $100,652.

- ERDF transportation and disposal: The planning cost for disposal and transportation is $980 per container without overhead charges. This cost includes the disposal fee, the transportation cost from the wastes site staging area to ERDF, and the replacement of the loaded container with an empty container at the staging area.
  - Total number of containers required: 3,265
  - Cost of containers: $3,676,732.

Construction Staff: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. This activity is considered a lump sum cost to the project.

- Duration of project: 291 days
- Planning cost for field management: $781,749
- Planning cost for final D&D report: $8,920.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.3.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. This activity is considered a lump sum cost to the project. The final site survey by the FH survey team is part of the as-built process and is based on the area of the waste site.

- Duration of project management: 291 days
- Project management cost: $496,398
- Planning cost for final D&D report: $2,019
- Area of final site survey: 5 acres
- Planning cost for final site survey: $2,043.

Annual Cost: No annual costs are associated with Alternative 3. No site monitoring is required because all of the contaminated waste will be removed.

F3.3.6 Representative Waste Site 216-A-36B Crib (Cost Tables F-8 and F-9)

The site work is estimated to take 1,316 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown.

- Mobilization: 15 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites

- Excavate contaminated and uncontaminated soil: 629 days

- Restore site: 658 days to backfill and revegetate the site
- Demobilize: 15 days.

Total construction duration = 1,316 days = 263 weeks = 63 months.

Site Description: The basis for the following information can be found in Table F-1.

- Area of contamination: 500 ft x 11 ft = 5,500 ft^2
- Depth of clean overburden: 22 ft bgs
- Total excavated depth: 303 ft bgs
- Volume of contaminated soil to be removed: 57,241 yd^3
- Total excavated volume (1.5:1 side slopes): 12,817,234 yd^3
- Volume of clean overburden: 12,759,993 yd^3
- Volume of borrow from onsite source: 57,241 yd^3.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories.

Typical heavy equipment mobilized to and demobilized from the site is as follows:

- Six large dozers, 300 to 400 hp
- Twelve 40- to 44-yd^3 scrapers
- One 2- to 3-yd^3 excavator
- Two 7-yd^3 loaders
- Backhoe loader
- Two farm tractors
- Two motor graders
- Eighteen semi-tractors and 20-yd^3 bottom dump trailers
- Four 4,000- to 6,000-gal water trucks
- One flatbed truck
- Three trucks with tilt container beds
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $103,116 to mobilize. The cost to demobilize is planned at $103,116, which also includes the decontamination of the equipment included, along with moving the equipment to the storage yard.

Contractor personnel are given training before the start of work at the site. The cost of training is planned at $103,116. The training will meet site requirements to work at a waste site. The four typical crews were used to calculate the cost of training.

The contractor will set up or construct a temporary staging area, two office trailers, change trailer, storage container, truck scales, and survey building at a cost of $260,675. The rental cost of the trailers, scales, and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $108,814. Decontamination areas will be set up as part of the site mobilization at a cost of $12,128. The staging area and roads will be scarified as part of demobilization and the planning cost is $585. The decontamination areas also will be removed at a planning cost of $5,801. The office trailers, truck scales, and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site is $56,321 to construct and $8,202 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $106,892 and is based on the area of the waste site.

Monitoring and Sampling: FH will perform all sampling required.

Soil sampling (noncontaminated soil, ERDF certification, pre-verification, verification samples). See Section F3.3.1 for sampling rate and process.

- Noncontaminated samples (includes QA samples): 7 samples
- ERDF certification samples (includes QA samples): 75 samples
- Pre-verification samples (includes QA samples): 147 samples
- Verification samples (includes QA samples): 293 samples
- Soil-sampling cost: $3,558,082.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 1,316 samples
- Quarterly environmental permit samples: 44 samples
- Air-sampling cost: $811,936.

Field sampling FH crew support:

- Sampling crew: 1,882 hours
- Sampling crew cost: $211,070.

Site Work: This activity covers the backfilling of the site with the overburden soil and soil hauled from an onsite borrow source. This activity has three items of work: loading and hauling the overburden, loading and hauling the borrow soil, and spreading backfill at the site. Dust control is included in this work. See Section F3.3.1 for crews and production rates. For this site, four crews will be used due to the amount of overburden and borrow soil to be hauled and spread. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.

- Load/haul overburden volume: 12,759,993 yd^3
- Planning cost to load/haul overburden: $18,905,702
- Load/haul borrow soil volume: 57,241 yd^3
- Planning cost to load/haul borrow soil: $199,305
- Spread backfill/compaction volume: 12,817,234 yd^3
- Planning cost to spread backfill/compaction: $6,374,273

- Miscellaneous cleanup duration: 263 weeks
- Planning cost for miscellaneous cleanup: $32,076.

Site revegetation is part of site restoration. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site, overburden stockpile, staging areas, and access roads.

- Total area to be revegetated: 148 acres
- Planning cost for reseeding: $106,485
- Planning cost for planting sagebrush: $135,473
- Planning cost for irrigation: $828,196.

Soil Excavation:

- Excavation: The work activities covered by Excavation include stripping and stockpiling overburden soil, and excavation of contaminated soil. The contaminated soil will be placed directly into the ERDF containers. The moving of the containers from the excavation site and the processing of the containers are covered in the container loading and handling process description (see below). Dust suppression is included in each activity. A description of how the work is performed is presented in Section F3.3.1. For this site, four crews will be used due to the amount of overburden and contaminated soil to be removed.

  - Overburden soil removed and stockpiled: 12,759,993 yd^3
  - Planning cost to remove overburden: $22,138,982
  - Excavation of contaminated soil: 57,241 yd^3
  - Planning cost to excavate contaminated soil: $415,991
  - RCT support for soil excavation: 14,357 hours
  - RCT Excavation support cost: $872,544
  - FH industrial safety support: 811 hours
  - FH industrial safety cost: $70,593.

- Container loading and handling process: This activity involves installing liners in containers, hauling the containers to a survey area, weighing, and unloading at a temporary storage area. See Section F3.3.1 for details of how the work is performed. For this site, four crews will be used due to the amount of contaminated soil to be handled.

  - Number of ERDF containers hauled, weighed, and processed: 5,204
  - Planning cost for hauling and securing the containers: $412,387
  - Planning cost for preparing containers for loading: $403,285
  - Planning cost for weighing and storing containers: $210,993
  - RCT support for queue operations survey: 595 hours
  - RCT support for queue operations planning cost: $36,628
  - RCT support for container radiation surveying: 3,570 hours
  - RCT support for container radiation surveying planning cost: $219,773.

- ERDF transportation and disposal: The planning cost for disposal and transportation is $980 per container without overhead charges. This cost includes the disposal fee, the transportation cost from the wastes site staging area to ERDF, and the replacement of the loaded container with an empty container at the staging area.
  - Total number of containers required: 5,204
  - Cost of containers: $5,859,212.

Construction Staff: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. This activity is considered a lump sum cost to the project.

- Duration of project: 1,316 days
- Planning cost for field management: $6,035,700
- Planning cost for final D&D report: $8,920.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.3.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. This activity is considered a lump sum cost to the project. The final site survey by the FH survey team is part of the as-built process and is based on the area of the waste site.

- Duration of project management: 1,316 days
- Project management cost: $2,358,825
- Planning cost for final D&D report: $2,019.

Annual Cost: No annual costs are associated with Alternative 3. No site monitoring is required because all of the contaminated waste will be removed.

F3.3.7 Representative Waste Site 216-A-36B Crib with Transuranic Waste Removal (Cost Tables F-8 and F-9)

The site work is estimated to take 1,316 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown.

- Mobilization: 15 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites

- Excavate contaminated and uncontaminated soil: 629 days

- Restore site: 658 days to backfill and revegetate the site
- Demobilize: 15 days.

Total construction duration = 1,316 days = 263 weeks = 63 months.

Site Description: The basis for the following information can be found in Table F-1.

- Area of contamination: 500 ft x 11 ft = 5,500 ft^2
- Depth of clean overburden: 22 ft bgs
- Total excavated depth: 303 ft bgs
- Volume of contaminated soil to be removed: 56,629 yd^3
- Volume of TRU contaminated soil to be removed: 612 yd^3
- Total excavated volume (1.5:1 side slopes): 12,817,234 yd^3
- Volume of clean overburden: 12,759,993 yd^3
- Volume of borrow from onsite source: 57,241 yd^3.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories.

Typical heavy equipment mobilized to and demobilized from the site is as follows:

- Six large dozers, 300 to 400 hp
- Twelve 40- to 44-yd^3 scrapers
- One 2- to 3-yd^3 excavator
- One 1-yd^3 excavator
- One 10-ton crane
- One 2- to 3-yd^3 loader
- Two 7-yd^3 loaders
- Backhoe loader
- Two farm tractors
- Two motor graders
- Eighteen semi-tractors and 20-yd^3 bottom dump trailers
- One semi-tractor and flatbed trailer
- Four 4,000- to 6,000-gal water trucks
- One flatbed truck
- Three trucks with tilt container beds
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $103,116 to mobilize. The cost to demobilize is planned at $103,116, which also includes the decontamination of the equipment included, along with moving the equipment to the storage yard.

Contractor personnel are given training before the start of work at the site. The cost of training is planned at $154,674. The training will meet site requirements to work at a waste site. The four typical crews were used to calculate the cost of training.

The contractor will set up or construct a temporary staging area, two office trailers, change trailer, storage container, truck scales, and survey building at a cost of $267,210. The rental cost of the trailers, scales, and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $108,814. Decontamination areas will be set up as part of the site mobilization at a cost of $100,853. The staging area and roads will be scarified as part of demobilization and the planning cost is $585. The decontamination areas also will be removed at a planning cost of $5,801. The office trailers, truck scales, and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site is $56,321 to construct and $8,202 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $106,892 and is based on the area of the waste site.

Monitoring and Sampling: FH will perform all sampling required.

Soil sampling (noncontaminated soil, ERDF certification, pre-verification, verification samples). See Section F3.3.1 for sampling rate and process.

- Noncontaminated samples (includes QA samples): 7 samples
- ERDF certification samples (includes QA samples): 75 samples
- Pre-verification samples (includes QA samples): 147 samples
- Verification samples (includes QA samples): 293 samples
- TRU samples (includes QA samples): 408 samples
- Soil-sampling cost: $4,962,837.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 1,316 samples
- Quarterly environmental permit samples: 44 samples
- Air-sampling cost: $811,936.

Field sampling FH crew support:

- Sampling crew: 5,498 hours
- Sampling crew cost: $315,708.

Site Work: This activity covers the backfilling of the site with the overburden soil and soil hauled from an onsite borrow source. This activity has three items of work: loading and hauling the overburden, loading and hauling the borrow soil, and spreading backfill at the site. Dust control is included in this work. See Section F3.3.1 for crews and production rates. For this site, four crews will be used due to the amount of overburden and borrow soil to be hauled and spread. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.

- Load/haul overburden volume: 12,759,993 yd^3
- Planning cost to load/haul overburden: $18,906,609
- Load/haul borrow soil volume: 57,241 yd^3
- Planning cost to load/haul borrow soil: $199,305
- Spread backfill/compaction volume: 12,817,234 yd^3
- Planning cost to spread backfill/compaction: $6,374,577
- Miscellaneous cleanup duration: 263 weeks
- Planning cost for miscellaneous cleanup: $32,076.

Site revegetation is part of site restoration. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site, overburden stockpile, staging areas, and access roads.

- Total area to be revegetated: 148 acres
- Planning cost for reseeding: $106,485
- Planning cost for planting sagebrush: $135,473
- Planning cost for irrigation: $828,196.

Soil Excavation:

- Excavation: The work activities covered by Excavation include stripping and stockpiling overburden soil, and excavation of contaminated soil. The contaminated soil will be placed directly into the ERDF containers. The moving of the containers from the excavation site and the processing of the containers are covered in the container loading and handling process description (see below). Dust suppression is included in each activity. A description of how the work is performed is presented in Section F3.3.1. For this site, four crews will be used due to the amount of overburden and contaminated soil to be removed.

  - Overburden soil removed and stockpiled: 12,759,993 yd^3
  - Planning cost to remove overburden: $22,140,044
  - Excavation of contaminated soil: 57,241 yd^3
  - Planning cost to excavate contaminated soil: $3,490,235
  - RCT support for soil excavation: 16,147 hours
  - RCT excavation support cost: $986,727
  - FH industrial safety support: 2,265 hours
  - FH industrial safety cost: $134,365.

- Container loading and handling process: This activity involves installing liners in containers, hauling the containers to a survey area, weighing, and unloading at a temporary storage area. See Section F3.3.1 for details of how the work is performed. For this site, four crews will be used due to the amount of contaminated soil to be handled.

  - Number of ERDF containers hauled, weighed, and processed: 5,149
  - Number of TRU containers hauled, weighed, and processed: 408
  - Planning cost for hauling and securing the containers: $500,578
  - Planning cost for preparing containers for loading: $539,041
  - Planning cost for weighing and storing containers: $353,370
  - RCT support for queue operations survey: 997 hours
  - RCT support for queue operations planning cost: $61,345
  - RCT support for container radiation surveying: 5,979 hours
  - RCT support for container radiation surveying planning cost: $420,268.

- ERDF transportation and disposal: The planning cost for disposal and transportation is $980 per container without overhead charges. This cost includes the disposal fee, the transportation cost from the wastes site staging area to ERDF, and the replacement of the loaded container with an empty container at the staging area.

  - Total number of containers required: 5,204
  - Cost of containers: $5,859,212.

- TRU transportation and storage: The planning cost for moving TRU containers to CWC for inspection, test, and temporary storage; waste profile study; sampling at INEEL; and transport to WIPP.

  - Total number of SWB containers required: 408
  - Planning cost: $4,888,200.

Construction Staff: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. This activity is considered a lump sum cost to the project.

- Duration of project: 1,316 days
- Planning cost for field management: $6,035,700
- Planning cost for final D&D report: $8,920.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.3.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. This activity is considered a lump sum cost to the project. The final site survey by the FH survey team is part of the as-built process and is based on the area of the waste site.

- Duration of project management: 1,316 days
- Project management cost: $2,358,825
- Planning cost for final D&D report: $2,019.

Annual Cost: No annual costs are associated with Alternative 3. No site monitoring is required because all of the contaminated waste will be removed.

F3.3.8 Representative Waste Site 207-A South Retention Basin (Cost Tables F-8 and F-9)

The site work is estimated to take 26 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown.

- Mobilization: 10 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites

- Excavate contaminated and uncontaminated soil: 2 days

- Restore site: 4 days to backfill and revegetate the site

- Demobilize: 10 days.

Total construction duration = 26 days = 3.7 weeks = 1.2 months.

Site Description: The basis for the following information can be found in Table F-1.

- Area of contamination: 157 ft x 119 ft = 18,683 ft^2
- Depth of clean overburden: 0 ft bgs
- Total excavated depth: 8 ft bgs
- Volume of contaminated soil to be removed: 0 yd^3
- Volume of concrete to be demolished: 117 yd^3
- Total excavated volume (1.5:1 side slopes): 117 yd^3
- Volume of clean overburden: 0 yd^3
- Volume of borrow from onsite source: 1,405 yd^3.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories.

Typical heavy equipment mobilized to and demobilized from the site is as follows:

- One large dozer
- One 2- to 3-yd^3 excavator with impact hammer, pulverizer, and thumb
- One 4- to 5-yd^3 wheel loader
- Backhoe loader
- Two farm tractors
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- One flatbed truck
- Three trucks with tilt container beds
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $6,652 to mobilize. The cost to demobilize is planned at $17,571, which also includes the decontamination of the equipment included, along with moving the equipment to the storage yard. This includes the FP labor to clean the equipment. The FH RCT labor hours support to decontamination of the construction equipment is 40 hours, which is planned at $2,462.

Contractor personnel are given training before the start of work at the site. The cost of training is planned at $27,743. The training will meet site requirements to work at a waste site. The four typical crews were used to calculate the cost of training.

The contractor will set up or construct a temporary staging area, two office trailers, change trailer, storage container, truck scales, and survey building at a cost of $37,804. The rental cost of the trailers, scales, and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $8,179. Decontamination areas will be set up as part of the site mobilization at a cost of $46,349. The staging area and roads will be scarified as part of demobilization and the planning cost is $814. The decontamination areas also will be removed at a planning cost of $21,404. The office trailers, truck scales, and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site is $3,283 to construct and $650 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $1,730 and is based on the area of the waste site.

Monitoring and Sampling: FH will perform all sampling required.

Soil sampling (noncontaminated soil, ERDF certification, pre-verification, verification samples). See Section F3.3.1 for sampling rate and process.

- Noncontaminated samples (includes QA samples): 1 sample
- ERDF certification samples (includes QA samples): 2 samples
- Pre-verification samples (includes QA samples): 16 samples

- Verification samples (includes QA samples): 8 samples
- Soil-sampling cost: $128,943.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 6 samples
- Quarterly environmental permit samples: 4 samples
- Air-sampling cost: $5,970.

Field sampling FH crew support:

- Sampling crew: 38 hours
- Sampling crew cost: $2,201.

Site Work: This activity covers the backfilling of the site with the overburden soil and soil hauled from an onsite borrow source. This activity has three items of work: loading and hauling the overburden, loading and hauling the borrow soil, and spreading backfill at the site. Dust control is included in this work. See Section F3.3.1 for crews and production rates. For this site, four crews will be used due to the amount of overburden and borrow soil to be hauled and spread. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.

- Load/haul overburden volume: 0 yd^3
- Planning cost to load/haul overburden: $0
- Load/haul borrow soil volume: 1,405 yd^3
- Planning cost to load/haul borrow soil: $7,127
- Spread backfill/compaction volume: 1,405 yd^3
- Planning cost to spread backfill/compaction: $3,055
- Miscellaneous cleanup duration: 7 weeks
- Planning cost for miscellaneous cleanup: $2,713.

Site revegetation is part of site restoration. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site, overburden stockpile, staging areas, and access roads.

- Total area to be revegetated: 5 acres
- Planning cost for reseeding: $5,764
- Planning cost for planting sagebrush: $6,425
- Planning cost for irrigation: $30,090.

Soil Excavation:

- Excavation: The work activities covered by Excavation include stripping and stockpiling overburden soil, and excavation of contaminated soil. The contaminated soil will be placed directly into the ERDF containers. The moving of the containers from the excavation site and the processing of the containers are covered in the container loading and handling process description (see below). Dust suppression is included in each

activity. A description of how the work is performed is presented in Section F3.3.1. For this site, four crews will be used due to the amount of overburden and contaminated soil to be removed.

- Overburden soil removed and stockpiled: 0 yd^3
- Planning cost to remove overburden: $0
- Excavation of contaminated soil: 0 yd^3
- Planning cost to excavate contaminated soil: $0
- Remove demolished concrete: 117 yd^3
- Planning cost to remove demolished concrete: $3,325
- RCT support for soil excavation: 3 hours
- RCT excavation support cost: $277
- FH industrial safety support: 16 hours
- FH industrial safety cost: $1,091.

• Container loading and handling process: This activity involves installing liners in containers, hauling the containers to a survey area, weighing, and unloading at a temporary storage area. See Section F3.3.1 for details of how the work is performed. For this site, four crews will be used due to the amount of contaminated soil to be handled.

  - Number of ERDF containers hauled, weighed, and processed: 11
  - Planning cost for hauling and securing the containers: $1,802
  - Planning cost for preparing containers for loading: $1,280
  - Planning cost for weighing and storing containers: $507
  - RCT support for queue operations survey: 3 hours
  - RCT support for queue operations planning cost: $92
  - RCT support for container radiation surveying: 9 hours
  - RCT support for container radiation surveying planning cost: $554.

• ERDF transportation and disposal: The planning cost for disposal and transportation is $980 per container without overhead charges. This cost includes the disposal fee, the transportation cost from the wastes site staging area to ERDF, and the replacement of the loaded container with an empty container at the staging area.

  - Total number of containers required: 11
  - Cost of containers: $15,533.

Construction Staff: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. This activity is considered a lump sum cost to the project.

- Duration of project: 26 days
- Planning cost for field management: $69,847
- Planning cost for final D&D report: $8,920.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.3.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. This activity is considered a lump sum cost to the project. The final site survey by the FH survey team is part of the as-built process and is based on the area of the waste site.

- Duration of project management: 26 days
- Project management cost: $69,847
- Planning cost for final D&D report: $2,019
- Area of final site survey: 3 acres
- Planning cost for final site survey: $408.

Annual Cost: No annual costs are associated with Alternative 3. No site monitoring is required because all of the contaminated waste will be removed.

F3.3.9 Representative Waste Site 216-A-37-1 Crib (Cost Tables F-8 and F-9)

The site work is estimated to take 113 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown.

- Mobilization: 10 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites

- Excavate contaminated and uncontaminated soil: 62 days

- Restore site: 31 days to backfill and revegetate the site

- Demobilize: 10 days.

Total construction duration = 113 days = 22.6 weeks = 5.3 months.

Site Description: The basis for the following information can be found in Table F-1.

- Area of contamination: 775 ft x 85 ft = 484,375 ft^2
- Depth of clean overburden: 6 ft bgs
- Total excavated depth: 25 ft bgs
- Volume of contaminated soil to be removed: 24,651 yd^3
- Total excavated volume (1.5:1 side slopes): 32,436 yd^3
- Volume of clean overburden: 7,785 yd^3
- Volume of borrow from onsite source: 24,651 yd^3.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories.

Typical heavy equipment mobilized to and demobilized from the site is as follows:

- One large dozer
- One 2- to 3-yd^3 excavator
- One 4- to 5-yd^3 wheel loader
- Two off-highway dump trucks
- Backhoe loader
- Two farm tractors
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- One flatbed truck
- Three trucks with tilt container beds
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $5,862 to mobilize. The cost to demobilize is planned at $16,572, which also includes the decontamination of the equipment included, along with moving the equipment to the storage yard. This includes the FP labor to clean the equipment. The FH RCT labor hours support to decontamination of the construction equipment is 40 hours, which is planned at $2,462.

Contractor personnel are given training before the start of work at the site. The cost of training is planned at $27,743. The training will meet site requirements to work at a waste site. The four typical crews were used to calculate the cost of training.

The contractor will set up or construct a temporary staging area, two office trailers, change trailer, storage container, truck scales, and survey building at a cost of $57,757. The rental cost of the trailers, scales, and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $8,226. Decontamination areas will be set up as part of the site mobilization at a cost of $46,349. The staging area and roads will be scarified as part of demobilization and the planning cost is $862. The decontamination areas also will be removed at a planning cost of $21,020. The office trailers, truck scales, and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site is $7,310 to construct and $1,448 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $3,461 and is based on the area of the waste site.

Monitoring and Sampling: FH will perform all sampling required.

Soil sampling (noncontaminated soil, ERDF certification, pre-verification, verification samples). See Section F3.3.1 for sampling rate and process.

- Noncontaminated samples (includes QA samples): 7 samples
- ERDF certification samples (includes QA samples): 34 samples

- Pre-verification samples (includes QA samples): 16 samples
- Verification samples (includes QA samples): 14 samples
- Soil-sampling cost: $218,403.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 180 samples
- Quarterly environmental permit samples: 6 samples
- Air-sampling cost: $111,044.

Field sampling FH crew support:

- Sampling crew: 469 hours
- Sampling crew cost: $27,173.

Site Work: This activity covers the backfilling of the site with the overburden soil and soil hauled from an onsite borrow source. This activity has three items of work: loading and hauling the overburden, loading and hauling the borrow soil, and spreading backfill at the site. Dust control is included in this work. See Section F3.3.1 for crews and production rates. For this site, four crews will be used due to the amount of overburden and borrow soil to be hauled and spread. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.

- Load/haul overburden volume: 7,785 yd^3
- Planning cost to load/haul overburden: $18,959
- Load/haul borrow soil volume: 24,652 yd^3
- Planning cost to load/haul borrow soil: $165,002
- Spread backfill/compaction volume: 32,436 yd^3
- Planning cost to spread backfill/compaction: $81,127
- Miscellaneous cleanup duration: 27 weeks
- Planning cost for miscellaneous cleanup: $10,468.

Site revegetation is part of site restoration. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site, overburden stockpile, staging areas, and access roads.

- Total area to be revegetated: 6 acres
- Planning cost for reseeding: $6,917
- Planning cost for planting sagebrush: $7,710
- Planning cost for irrigation: $36,109.

Soil Excavation:

- Excavation: The work activities covered by Excavation include stripping and stockpiling overburden soil, and excavation of contaminated soil. The contaminated soil will be placed directly into the ERDF containers. The moving of the containers from the excavation site and the processing of the containers are covered in the container loading and handling process description (see below). Dust suppression is included in each activity. A description of how the work is performed is presented in Section F3.3.1. For this site, four crews will be used due to the amount of overburden and contaminated soil to be removed.

- Overburden soil removed and stockpiled: 7,785 yd^3
- Planning cost to remove overburden: $38,387
- Excavation of contaminated soil: 24,652 yd^3
- Planning cost to excavate contaminated soil: $145,831
- RCT support for soil excavation: 645 hours
- RCT excavation support cost: $39,706
- FH industrial safety support: 496 hours
- FH industrial safety cost: $33,833.

• Container loading and handling process: This activity involves installing liners in containers, hauling the containers to a survey area, weighing, and unloading at a temporary storage area. See Section F3.3.1 for details of how the work is performed. For this site, four crews will be used due to the amount of contaminated soil to be handled.

- Number of ERDF containers hauled, weighed, and processed: 2,203
- Planning cost for hauling and securing the containers: $200,407
- Planning cost for preparing containers for loading: $195,636
- Planning cost for weighing and storing containers: $101,703
- RCT support for queue operations survey: 184 hours
- RCT support for queue operations planning cost: $11,327
- RCT support for container radiation surveying: 1,104 hours
- RCT support for container radiation surveying planning cost: $67,963.

• ERDF transportation and disposal: The planning cost for disposal and transportation is $980 per container without overhead charges. This cost includes the disposal fee, the transportation cost from the wastes site staging area to ERDF, and the replacement of the loaded container with an empty container at the staging area.

- Total number of containers required: 2,203
- Cost of containers: $2,481,836.

Construction Staff: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. This activity is considered a lump sum cost to the project.

- Duration of project: 113 days
- Planning cost for field management: $303,565
- Planning cost for final D&D report: $8,920.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.3.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. This activity is considered a lump sum cost to the project. The final site survey by the FH survey team is part of the as-built process and is based on the area of the waste site.

- Duration of project management: 113 days
- Project management cost: $192,759
- Planning cost for final D&D report: $2,019
- Area of final site survey: 4 acres
- Planning cost for final site survey: $1,634.

Annual Cost: No annual costs are associated with Alternative 3. No site monitoring is required because all of the contaminated waste will be removed.

F3.3.10 Sites with Special Conditions (Cost Tables F-8 and F-9)

Site 216-A-34 Ditch: This site has a large concrete head wall for the discharge pipe. The headwall is demolished and removed as part of the RTD for this site. For planning purposes, the headwall consists of about 11 yd^3 of concrete that can be broken up with an impact hammer and pulverizer-equipped excavator. The removal process will be the same as described in Section F3.3.1.15.

Site 209-E-WS-3 Hold-Up Tank: Two concrete structures are located at this site. One structure is a small concrete valve box stacked on top of a 50-gal concrete tank. For planning purposes, the valve box and tank are considered empty of liquids and solid waste. Minor piping will be in the valve box, but will have the same level of contamination as the valve box. The structures will consist of about 7 yd^3 of concrete that can be broken up with an impact hammer and pulverizer-equipped excavator. The removal process will be the same as described in Section F3.3.1.15.

Site 270-E-1 Neutralization Tank: This is a large underground steel tank with a large-diameter riser extending to the surface. The tank was filled with limestone during operation of the adjoining facility. It is expected that limestone is still present in the tank and that it is filled to the discharge level of the tank. The limestone is expected to be easily removed with an excavator and will be shipped to ERDF without special handling. The tank will be cut up and removed using a shear mounted on an excavator. Liquids are not expected to be encountered in the tank. The removal process will be the same as described in Section F3.3.1.15.

Site 200-E-58 Neutralization Tank: This tank will be handled the same as the 270-E-1 Neutralization Tank.

Site 216-A-36A Crib: Two removal processes are planned for this site. The planned deep excavation of this site will be handled the same as the 216-A-36B Crib described in

Section F3.3.6. The planned deep excavation with TRU waste removal for this site will be handled the same as Site 216-A-36B Crib with TRU waste removal described in Section F3.3.7.

Sites 203-S Basin, 204-S Basin, 205-S Building Foundation, 205-S Vault: The four sites have been listed together as one RTD site. All sites are close together and involve demolition of minor concrete belowground structures and foundations. The removal process will be the same as described in Section F3.3.1.15.

Trenches and cribs are excavated to the required depth and contaminated material is removed to ERDF for disposal. The sites are then remediated. Excavation depth and mixing requirements are different for each group of trenches and cribs.

F3.4 ALTERNATIVE 4 – SURFACE BARRIERS

Hanford, ET Capillary, or Biological Barriers will be constructed over trenches, ditches, tanks, retention basins, or cribs. For planning purposes, the side overlap for all types of barriers will be 20 ft for all exterior sides.

F3.4.1 General Assumptions

The general assumptions for Alternative 4 are as follows.

F3.4.1.1 Fieldwork such as mobilization/demobilization, borrow site excavation, barrier fill, revegetation, and some of the post-construction work will be contracted to an FP contractor. project management, RCT support, sampling, and Safety oversight will be performed by FH.

F3.4.1.2 Mobilization and startup include site training, mobilization of equipment and personnel, installation of temporary construction fences, construction of access roads, and setting up offices and storage trailers with utilities. Air sampling will be performed during the construction of the first layer of the barrier. A minimum of two samples will be taken per day. The planning cost per sample is $520. The sampling crew consists of one sampler and one RCT.

F3.4.1.3 Revegetation of the waste site barrier includes planting native dry land grass using tractors with seed drills and hand broadcasting, hand planting sagebrush seedlings, and irrigation for four times in the spring or early summer. All disturbed areas, such as around the barrier, stockpile, staging areas, and access roads, will be replanted. Sagebrush will not be planted on the Biological Barrier sites.

F3.4.1.4 The FH Project Management team consists of a part-time project manager, with a full-time field supervisor and part-time engineering support. QA, Radiological Control, and Safety also provide oversight along with other support for contract management, and project controls. Total hours for this staff are planned at 22.5 hours per day. The duration of this work is based on total project duration.

F3.4.1.5 The FP contractor field supervisory team consists of a full-time construction manager and field supervisor, along with part-time QA, construction safety, and clerical support. Two pickup trucks are included in the cost. Total hours for this staff are planned at 21 hours per day. The duration of this work is based on total project duration.

F3.4.1.6 Demobilization will include demobilization of equipment and personnel, and removal of temporary construction fences, access roads, and office/storage trailers.

F3.4.1.7 There are two onsite sources for the fill materials to construct the three soil/fill layers. The source for engineered fill is located at Pit 30 approximately halfway between the 200 East and 200 West Areas. This pit is assumed to have the sufficient quantity for this project. The source for the silt required for Layers 1 and 2 is located at Area C about 2 miles south of the 200 West Area.

F3.4.1.8 The sand, drainage gravel, gravel filter, crushed base course, fractured basalt, and asphalt pavement will be supplied by offsite vendors or from commercial gravel pits. These materials are delivered to the waste site by the vendor.

F3.4.1.9 All barrier sites are considered to have settled and are compacted enough to support construction of a barrier without further settling. Dynamic compaction is not used to pre-compact the site.

F3.4.1.10 Sites that will get a Hanford Barrier, Biological Barrier, or an ET Capillary Barrier are considered level and will not require pre-leveling before the start of construction of the barrier.

F3.4.1.11 Retention basin sites will require additional backfill soil to fill the basin to the level of the surrounding ground before the start of construction of the barrier.

F3.4.1.12 The Hanford Barrier will consist of nine different layers.

- The bottom layer, Layer 9, will be constructed of 40 in. of engineered fill. The construction of the engineered fill requires the excavation of suitable borrow from an onsite pit source. The estimated time to complete the fill is based on the production rate of a 4- to 5-yd^3 loader excavating at the pit. All material is screened with a grizzly mounted on a surge bin to remove 4 in. or larger rocks. Six semi-tractor trucks with 20-yd^3 bottom dump trailer trailers are needed to keep up with the loader. A 6,000-gal water tanker provides dust control at the pit. The production rate for this work is 185 L yd^3/h. The spreading and compaction equipment used at the barrier is a 250- to 300-hp dozer with a U-blade to spread fill, and two 12-ton vib tandem rollers. A truck with a 6,000-gal water trailer provides dust control.

- To produce a smooth surface to prevent low areas, the surface of engineered fill is fine graded. Work involves a motor grader, 4- to 5-yd^3 loader, two 12-ton vib single drum rollers, and a water tanker. The production rate is 5,000 yd^2/day for the engineered fill surface area. One laborer supports the grader operator as a grade checker. Two engineer technicians set up the grade and elevation control.

- The next layer, Layer 8, will consist of 4 in. of crush-surfacing base course. This material will come from a commercial source and will be delivered and stockpiled at the construction site. The delivered cost of material, based on vendor quotes, is \$17.61/yd^3. The equipment used for this work is a motor grader, a 12-ton vib tandem roller, and a truck with a 6,000-gal water trailer. Two equipment operators and one truck driver operate the equipment. One laborer supports the grader operator as a grade checker and helps unload trucks. The production rate for this work is 641 yd^2/h.

- Layer 7 is the 6-in. asphalt concrete pavement (ACP) layer. The material is from a commercial source and is delivered to the site using the supplier's trucks. The delivered cost of material, based on vendor quotes, is \$45.50/ton. The ACP has doubled the amount of asphalt (6 to 8 percent) in the mix design. The other equipment used to construct this layer is a paving machine and two 12-ton vib tandem rollers. The production rate for this work is 100 ton/h. Three equipment operators operate the equipment while six laborers help unload trucks, rake asphalt, or support grade control.

- Layer 6 is a 6-in. layer of drainage gravel that is constructed on top of the ACP layer. Work covers the spreading, compacting, and grading of the drainage gravel. The gravel will come from an onsite source. The gravel will be delivered by haul truck spread on the ACP. The equipment used to construct this layer is a motor grader, two 12-ton vib tandem rollers, and a truck with a 6,000-gal water trailer. The production rate for this work is 208 yd^3/h. Three equipment operators and one truck driver operate the equipment. One laborer supports the grader operator as a grade checker and helps unload trucks.

- Layer 5 is an edge berm and 60-in. layer of fractured basalt. Work includes the spreading and compacting of the fractured basalt used for the layer and berm. The material is from a commercial source and is delivered to the site by the supplier.

- Layer 4 is 6 in. of gravel filter rock. Work includes the spreading, compacting, and fine grading of the 1/4 in. minus gravel filter. The material is from a commercial source and is delivered to the site by the supplier. The delivered cost of material, based on vendor quotes, is \$16.70/yd^3. The equipment used to construct this layer is a motor grader, two 12-ton vib tandem rollers, and a truck with a 6,000-gal water trailer. The production rate for this work is 208 yd^3/h. Three equipment operators and one truck driver operate the equipment. One laborer supports the grader operator as a grade checker and helps unload trucks.

- Layer 3 is 6 in. of sand. Work covers the spreading, compacting, and fine grading of the filter sand used for Layer 3. The gravel will come from an onsite source. The gravel will be delivered by haul truck spread on the gravel filter layer. The equipment used to construct this layer is a motor grader, two 12-ton vib tandem rollers, and a truck with a 6,000-gal water trailer. The production rate for this work is 208 yd^3/h. Three equipment operators and one truck driver operate the equipment. One laborer supports the grader operator as a grade checker and helps unload trucks.

- Layer 3 will be fine graded to produce a smooth surface before placement of the geotextile. Work involves a motor grader, a 4- to 5-yd^3 loader, one 12-ton vib single drum roller, and a water tanker. The production rate is 2,500 yd^2/h for the engineered fill surface area. One laborer supports the dozer operator and the water truck driver. Two engineer technicians set up the grade and elevation control.

- A geotextile is placed on top of Layer 3. This item of work covers the placement of needle-punched 120 mil polypropylene geotextile over the sand filter layer. The production rate is 150 yd^2/h. Three laborers place and splice the fabric.

- The construction of Layer 2 involves excavating and hauling the silt from the onsite pit to the barrier. This layer is 20 in. deep. The production rate is based on a 4- to 5-yd^3 loader excavating and loading at the pit. Six trucks are 20-yd^3 bottom dump trailer and semi-tractor combinations. The production rate for this work is 185 L yd^3/h based on the production of the loader. At the barrier, the silt is spread with a 200- to 250-hp low-ground-pressure dozer. The silt is scarified to prevent overcompaction. Trucks with a 6,000-gal water trailer provide dust control at the pit and the barrier.

- Layer 1 requires a 20-in.-deep layer of fill material consisting of silt with 15 percent pea gravel added by weight. The silt is excavated with a 4- to 5-yd^3 loader and hauled from the site silt source by two dump trucks to a process area near the pit. Pea gravel will be provided from an onsite source and will be hauled and stockpiled at the silt process area. A 4- to 5-yd^3 loader and a pug mill with belt loader are used to mix the silt and gravel. The hauling from the process area is the same as described for Layer 2. Spreading is the same as Layer 2. The side slopes of the barrier will be covered with 1-ft-deep fractured basalt and 1-ft-deep engineered fill.

F3.4.1.13 The ET Capillary Barrier will consist of four different layers.

- The bottom layer will be constructed of 20 in. of engineered fill. The process will be the same as the Hanford Barrier Layer 9.

- The third layer will be constructed of 6 in. of sand covered with geotextile. The process will be the same as the Hanford Barrier Layer 6, including the geotextile cover.

- The second layer will be constructed of 20 in. of silt fill. The process will be the same as the Hanford Barrier Layer 2.

- The top layer will be constructed of 20 in. of silt/pea gravel fill. The process will be the same as the Hanford Barrier Layer 1.

- The side slopes of the barrier will be covered with 1-ft-deep fractured basalt and 1-ft-deep engineered fill.

  - The side slopes of the barrier will be graded before placing any ballast, gravel filter, or fractured basalt. The work involves a 100- to 150-hp dozer with laser controls, a 4- to 5-yd^3 loader, one 12-ton vib single drum roller, and a water tanker. The production rate is 2,500 yd^2/h for the engineered fill surface area. One laborer supports the dozer operator and the water truck driver. Two engineer technicians set up the grade and elevation control.

- The construction of the ballast and the gravel filter for the side slope follows the grading of the side slope. A truck with a water trailer provides dust control. The production rate for this work is 125 L yd^3/h. The spreading and compaction equipment used at the barrier to spread fill is a 4- to 5-yd^3 loader, a 100- to 150-hp dozer with laser controls, and one 12-ton vib single drum roller. One laborer supports the dozer operator and the water truck driver. Both gravel layers are 6 in. deep. The ballast and the gravel filter will come from a commercial source and will be delivered and stockpiled at the construction site. The delivered cost for ballast is $\$19.98/yd^3$ and $\$16.70/yd^3$, based on vendor quotes.

- The fractured basalt with silt layer is the last layer of the side slopes to be constructed. The fractured basalt will come from a commercial source and will be delivered and stockpiled at the construction site. The delivered cost of the rock is based on vendor quotes of $\$21.61/yd^3$. The silt will come from the same source as Layer 2. The silt will be delivered and stockpiled at the barrier site when the silt for Layer 2 is being hauled. One loader and a 300-hp dozer are used to place the basalt on the fill slope. One laborer supports the work. The production rate is 70 loose yd^3/h. A quarter-time water truck and driver are used for dust control.

F3.4.1.14 The Biological Barrier will consist of two different layers.

- The bottom layer will be constructed of 3 ft of engineered fill. The process will be the same as for the Hanford Barrier Layer 9.

- The top layer will be constructed of 20 in. of silt/pea gravel fill. The process will be the same as for the Hanford Barrier Layer 1.

F3.4.1.15 Instrumentation is not included for this series of barriers.

F3.4.1.16 After completion of the barrier construction work, a 4-ft steel post with chain fence will be built around the site. The fence location is at the toe of the barrier slope.

F3.4.1.17 During the construction of the barrier, compaction testing will be performed on the three layers of fill. The lower level will require that a minimum level of compaction has been reached. The top two layers will be tested to ensure that the fill does not become overcompacted.

F3.4.2 Representative Waste Site 216-A-19 Trench

The site work is estimated to take 30 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown. The construction process will use one crew to perform the work.

- Mobilization: 15 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites
- Capping: 4 days
- Revegetation: 1 day
- Demobilize: 10 days.

Total construction duration = 30 days = 6 weeks = 1.4 months.

Site Description: The basis for the following information can be found in Table F-1.

- Area of waste site contamination: 25 ft x 25 ft = 625 ft^2
- Area of waste site with 20-ft overlap: (25+(20x2)) x (25+(20x2)) = 4,225 ft^2
- Type of cap: ET Capillary
- Side slope of cap: 3:1
- Depth of pre-leveling required: 0 ft
- Depth of cap: 5.5 ft
- Horizontal side slope distance: 22.8 ft
- Cap footprint length: (25+((20+22.8)x2)) = 110 ft
- Cap footprint width: (25+((20+22.8)x2)) = 110 ft
- Area of cap footprint: 110 x 110 = 12,100 ft^2.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories.

Typical heavy equipment mobilized to and demobilized from the site is as follows:

- Large dozer
- Two LPG dozers
- 2- to 3-yd^3 excavator
- Two 4- to 5-yd^3 wheel loaders
- Soil vib rollers
- Two off-highway dump trucks
- Pug mill with hoppers and belt loaders
- Two farm tractors
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks

- Flatbed truck
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $25,270 to mobilize and to demobilize.

Contractor personnel are given training before the start of work at the site. The cost of training is planned at $9,440. The training will meet site requirements to work at a waste site.

The contractor will set up or construct a temporary staging area, office trailers, change trailer, and storage container at a cost of $9,440. The rental cost of the trailers and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $8,605. The staging area and roads will be scarified as part of demobilization and the planning cost is $688. The office trailers and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site is $4,143 to construct and $640 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $2,967 and is based on the area of the waste site.

Fluor Hanford Sampling and Crew Support: FH will perform all sampling required.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 1 sample
- Quarterly environmental permit samples: 4 samples
- FH sampling crew: 10 hours
- Air-sampling cost: $3,609.

Site Work:

- Installation of cap: Site 216-A-9 Trench requires an ET Capillary Barrier. The design, construction, and production rates for the barrier are discussed above in the General Assumptions. The following areas and volumes will be used for the cost estimates:
  - Area (footprint) of cap: 12,100 ft^2
  - Pre-level volume: 0 yd^3
  - Layer 8 – volume of engineered fill: 614 yd^3
  - Layer 3 – volume of sand: 160 yd^3
  - Layer 3 – area of geotextile: 832 yd^2
  - Layer 2 – volume of silt: 435 yd^3
  - Layer 1 – volume of silt and pea gravel mixture: 333 yd^3
  - Side slope – volume of gravel filter: 146 yd^3

- Side slope – volume of ballast: 146 yd^3
- Side slope – volume of fractured basalt and silt: 413 yd^3.

* The planning costs for the layers are as follows:
  - Pre-level: $0
  - Layer 8 engineered fill: $6,650
  - Layer 3 sand: $7,971
  - Layer 2 silt: $4,701
  - Layer 1 silt and pea gravel: $3,516
  - Side slope: $31,150
  - Silt pit process operations: $3,734.

* Other items of work that are involved in the construction of the barrier are construction survey/elevation control, soils compaction testing, site cleanup, construction of a site fence, and FH RCT support. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.
  - Planning cost for surveying: $12,528
  - Planning cost for soils compaction testing: $1,700
  - Planning cost for miscellaneous cleanup: $1,642
  - Planning cost for site fence: $2,177
  - RCT support for construction cost: $526.

* Site revegetation is part of site work. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site cap, construction staging areas, and temporary access roads.
  - Total area to be revegetated: 3 acres
  - Planning cost for reseeding: $2,082
  - Planning cost for planting sagebrush: $2,894
  - Planning cost for irrigation: $14,811.

Fixed-Price Contractor Field Management: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. The activity is considered a lump sum cost to the project.

* Duration of project: 30 days
* Planning cost for field management: $99,412
* Planning cost for final D&D report: $10,020.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.4.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. The activity is considered a lump sum cost to the project.

- Duration of project management: 30 days
- Project management cost: $53,772
- Planning cost for final D&D report: $2,019.

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)
  - Area of cap system = 12,100 ft^2 = 1 acre (minimum)
  - Team hours to complete inspections = 0.87 days (1 day for every 50,000 ft^2)
  - Daily inspection rate (2 technicians) = $896/day ($56/h/person)
  - Barrier cover inspection of surface soil = $896 x 0.87 day = $781/event
  - Radiation surveys of surface soil = $1,000 for every 5,000 ft^2 = $8,712/event

- Cap maintenance (footprint of cap system)
  - Area of cap system = 1 acre(minimum)
  - Area requiring repair (10% of total area) = 848 yd^2
  - Volume of cap repair (2 ft) = 568 yd^3
  - Oversight (soil placement 130 yd^3/h) = 0.5 day
  - Oversight (vegetation 5,000 yd^2/h) = 0.2 day.

Oversight will be performed by one FH engineer at $60/h.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section F3.1.4.

F3.4.3 Representative Waste Site 216-B-12 Crib

The site work is estimated to take 35 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown. The construction process will use one crew to perform the work.

- Mobilization: 15 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites

- Capping: 9 days
- Revegetation: 1 day
- Demobilize: 10 days.

Total construction duration = 35 days = 7 weeks = 1.7 months.

Site Description: The basis for the following information can be found in Table F-1.

- Area of waste site contamination: 160 ft x 50 ft = 8,000 ft^2
- Area of waste site with 20-ft overlap: (160+(20x2)) x (50+(20x2)) = 18,000 ft^2
- Type of cap: ET Capillary
- Side slope of cap: 3:1
- Depth of pre-leveling required: 0 ft
- Depth of cap: 5.5 ft
- Horizontal side slope distance: 22.8 ft
- Cap footprint length: (160+((20+22.8)x2)) = 245.6 ft
- Cap footprint width: (50+((20+22.8)x2)) = 135.6 ft
- Area of cap footprint: 245.6 x 135.6 = 33,303 ft^2.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories.

Typical heavy equipment mobilized to and demobilized from the site is as follows:

- Large dozer
- Two LPG dozers
- 2- to 3-yd^3 excavator
- Two 4- to 5-yd^3 wheel loaders
- Soil vib rollers
- Two off-highway dump trucks
- Pug mill with hoppers and belt loaders
- Two farm tractors
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $25,270 to mobilize and to demobilize.

Contractor personnel are given training before the start of work at the site. The cost of training is planned at $9,440. The training will meet site requirements to work at a waste site.

The contractor will set up or construct a temporary staging area, office trailers, change trailer, and storage container at a cost of $9,440. The rental cost of the trailers and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $8,605. The staging area and roads will be scarified as part of demobilization and the planning cost is $688. The office trailers and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site is $5,715 to construct and $883 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $2,967 and is based on the area of the waste site.

Fluor Hanford Sampling and Crew Support: FH will perform all sampling required.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 2 samples
- Quarterly environmental permit samples: 4 samples
- FH sampling crew: 12 hours
- Air-sampling cost: $4,330.

Site Work:

- Installation of cap: Site 216-B-12 Crib requires an ET Capillary Barrier. The design, construction, and production rates for the barrier are discussed above in the General Assumptions. The following areas and volumes will be used for the cost estimates:

  - Area (footprint) of cap: 33,303 ft^2
  - Pre-level volume: 0 yd^3
  - Layer 8 – volume of engineered fill: 1,910 yd^3
  - Layer 3 – volume of sand: 526 yd^3
  - Layer 3 – area of geotextile: 2,744 yd^2
  - Layer 2 – volume of silt: 1,533 yd^3
  - Layer 1 – volume of silt and pea gravel mixture: 1,323 yd^3
  - Side slope – volume of gravel filter: 264 yd^3
  - Side slope – volume of ballast: 264 yd^3
  - Side slope – volume of fractured basalt and silt: 743 yd^3.

- The planning costs for the layers are as follows:

  - Pre-level: $0
  - Layer 8 engineered fill: $20,688
  - Layer 3 sand: $26,242
  - Layer 2 silt: $14,877
  - Layer 1 silt and pea gravel: $12,732
  - Side slope: $56,126
  - Silt pit process operations: $14,815.

- Other items of work that are involved in the construction of the barrier are construction survey/elevation control, soils compaction testing, site cleanup, construction of a site fence, and FH RCT support. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.

  - Planning cost for surveying: $14,836
  - Planning cost for soils compaction testing: $3,643
  - Planning cost for miscellaneous cleanup: $1,642
  - Planning cost for site fence: $3,749
  - RCT support for construction cost: $1,447.

- Site revegetation is part of site work. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site cap, construction staging areas, and temporary access roads.

  - Total area to be revegetated: 4 acres
  - Planning cost for reseeding: $2,776
  - Planning cost for planting sagebrush: $3,859
  - Planning cost for irrigation: $19,748.

Fixed-Price Contractor Field Management: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. The activity is considered a lump sum cost to the project.

- Duration of project: 35 days
- Planning cost for field management: $115,981
- Planning cost for final D&D report: $10,020.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.4.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. The activity is considered a lump sum cost to the project.

- Duration of project management: 35 days
- Project management cost: $62,734
- Planning cost for final D&D report: $2,019.

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)
  - Area of cap system = 33,303 ft^2 = 1 acre (minimum)
  - Team hours to complete inspections = 0.87 day (1 day for every 50,000 ft^2)
  - Daily inspection rate (2 technicians) = $896/day ($56/h/person)
  - Barrier cover inspection of surface soil = $896 x 0.87 day = $781/event
  - Radiation surveys of surface soil = $1,000 for every 5,000 ft^2 = $8,712/event

- Cap maintenance (footprint of cap system)
  - Area of cap system = 1 acre(minimum)
  - Area requiring repair (10% of total area) = 848 yd^2
  - Volume of cap repair (2 ft) = 568 yd^3
  - Oversight (soil placement 130 yd^3/h) = 0.5 day
  - Oversight (vegetation 5,000 yd^2/h) = 0.2 day.

Oversight will be performed by one FH engineer at $60/h.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section F3.1.4.

F3.4.4 Representative Waste Site 216-S-7 Crib

The site work is estimated to take 33 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown. The construction process will use one crew to perform the work.

- Mobilization: 15 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites

- Capping: 7 days

- Revegetation: 1 day

- Demobilize: 10 days.

Total construction duration = 33 days = 6.6 weeks = 1.6 months.

Site Description: The basis for the following information can be found in Table F-1.

- Area of waste site contamination: 50 ft x 100 ft = 5,000 ft^2
- Area of waste site with 20-ft overlap: (50+(20x2)) x (100+(20x2)) = 12,600 ft^2
- Type of cap: ET Capillary
- Side slope of cap: 3:1
- Depth of pre-leveling required: 0 ft
- Depth of cap: 5.5 ft
- Horizontal side slope distance: 22.8 ft
- Cap footprint length: (50+((20+22.8)x2)) = 135.6 ft
- Cap footprint width: (100+((20+22.8)x2)) = 185.6 ft
- Area of cap footprint: 135.6 x 185.6 = 25,167 ft^2.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories.

Typical heavy equipment mobilized to and demobilized from the site is as follows:

- Large dozer
- Two LPG dozers
- 2- to 3-yd^3 excavator
- Two 4- to 5-yd^3 wheel loaders
- Soil vib rollers
- Two off-highway dump trucks
- Pug mill with hoppers and belt loaders
- Two farm tractors
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $25,270 to mobilize and to demobilize.

Contractor personnel are given training before the start of work at the site. The cost of training is planned at $9,440. The training will meet site requirements to work at a waste site.

The contractor will set up or construct a temporary staging area, office trailers, change trailer, and storage container at a cost of $9,440. The rental cost of the trailers and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $8,605. The staging area and roads will be scarified as part of demobilization and the planning cost is $688. The office trailers and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site is $5,126 to construct and $792 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $2,967 and is based on the area of the waste site.

Fluor Hanford Sampling and Crew Support: FH will perform all sampling required.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 1 sample
- Quarterly environmental permit samples: 4 samples
- FH sampling crew: 10 hours
- Air-sampling cost: $3,609.

Site Work:

- Installation of cap: Site 216-S-7 Crib requires an ET Capillary Barrier. The design, construction, and production rates for the barrier are discussed above in the General Assumptions. The following areas and volumes will be used for the cost estimates:
  - Area (footprint) of cap: 25,167 ft^2
  - Pre-level volume: 0 yd^3
  - Layer 8 – volume of engineered fill: 1,408 yd^3
  - Layer 3 – volume of sand: 384 yd^3
  - Layer 3 – area of geotextile: 2,001 yd^2
  - Layer 2 – volume of silt: 1,106 yd^3
  - Layer 1 – volume of silt and pea gravel mixture: 936 yd^3
  - Side slope – volume of gravel filter: 220 yd^3
  - Side slope – volume of ballast: 220 yd^3
  - Side slope – volume of fractured basalt and silt: 619 yd^3.
- The planning costs for the layers are as follows:
  - Pre-level: $0
  - Layer 8 engineered fill: $15,250
  - Layer 3 sand: $19,147
  - Layer 2 silt: $9,828
  - Layer 1 silt and pea gravel: $8,317
  - Side slope: $46,750
  - Silt pit process operations: $10,480.

- Other items of work that are involved in the construction of the barrier are construction survey/elevation control, soils compaction testing, site cleanup, construction of a site fence, and FH RCT support. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.
  - Planning cost for surveying: $13,847
  - Planning cost for soils compaction testing: $2,793
  - Planning cost for miscellaneous cleanup: $1,642
  - Planning cost for site fence: $3,160
  - RCT support for construction cost: $1,052.
- Site revegetation is part of site work. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site cap, construction staging areas, and temporary access roads.
  - Total area to be revegetated: 4 acres
  - Planning cost for reseeding: $2,776
  - Planning cost for planting sagebrush: $3,859
  - Planning cost for irrigation: $19,748.

Fixed-Price Contractor Field Management: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. The activity is considered a lump sum cost to the project.

- Duration of project: 33 days
- Planning cost for field management: $109,353
- Planning cost for final D&D report: $10,020.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.4.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. The activity is considered a lump sum cost to the project.

- Duration of project management: 33 days
- Project management cost: $59,149
- Planning cost for final D&D report: $2,019.

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)
  - Area of cap system = 25,167 ft^2 = 1 acre (minimum)
  - Team hours to complete inspections = 0.87 day (1 day for every 50,000 ft^2)
  - Daily inspection rate (2 technicians) = \$896/day (\$56/h/person)
  - Barrier cover inspection of surface soil = \$896 x 0.87 day = \$781/event
  - Radiation surveys of surface soil = \$1,000 for every 5,000 ft^2 = \$8,712/event

- Cap maintenance (footprint of cap system)
  - Area of cap system = 1 acre(minimum)
  - Area requiring repair (10% of total area) = 848 yd^2
  - Volume of cap repair (2 ft) = 568 yd^3
  - Oversight (soil placement 130 yd^3/h) = 0.5 day
  - Oversight (vegetation 5,000 yd^2/h) = 0.2 day.

Oversight will be performed by one FH engineer at \$60/h.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section F3.1.4.

F3.4.5 Representative Waste Site 216-A-10 Crib

The site work is estimated to take 38 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown. The construction process will use one crew to perform the work.

- Mobilization: 15 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites

- Capping: 12 days

- Revegetation: 1 day

- Demobilize: 10 days.

Total construction duration = 38 days = 7.6 weeks = 1.8 months.

Site Description: The basis for the following information can be found in Table F-1.

- Area of waste site contamination: 275 ft x 45 ft = 12,375 ft^2
- Area of waste site with 20-ft overlap: (275+(20x2)) x (45+(20x2)) = 26,775 ft^2
- Type of cap: ET Capillary
- Side slope of cap: 3:1
- Depth of pre-leveling required: 0 ft
- Depth of cap: 5.5 ft
- Horizontal side slope distance: 22.8 ft
- Cap footprint length: (275+((20+22.8)x2)) = 360.6 ft
- Cap footprint width: (45+((20+22.8)x2)) = 130.6 ft
- Area of cap footprint: 360.6 x 130.6 = 47,094 ft^2.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories.

Typical heavy equipment mobilized to and demobilized from the site is as follows:

- Large dozer
- Two LPG dozers
- 2- to 3-yd^3 excavator
- Two 4- to 5-yd^3 wheel loaders
- Soil vib rollers
- Two off-highway dump trucks
- Pug mill with hoppers and belt loaders
- Two farm tractors
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $25,270 to mobilize and to demobilize.

Contractor personnel are given training before the start of work at the site. The cost of training is planned at $9,440. The training will meet site requirements to work at a waste site.

The contractor will set up or construct a temporary staging area, office trailers, change trailer, and storage container at a cost of $9,440. The rental cost of the trailers and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $8,605. The staging area and roads will be scarified as part of demobilization and the planning cost is $688. The office trailers and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site is $6,797 to construct and $1,050 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $5,934 and is based on the area of the waste site.

Fluor Hanford Sampling and Crew Support: FH will perform all sampling required.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 2 samples
- Quarterly environmental permit samples: 4 samples
- FH sampling crew: 12 hours
- Air-sampling cost: $4,330.

Site Work:

- Installation of cap: Site 216-A-10 Crib requires an ET Capillary Barrier. The design, construction, and production rates for the barrier are discussed above in the General Assumptions. These areas and volumes will be used for the cost estimates:
  - Area (footprint) of cap: 25,167 ft^2
  - Pre-level volume: 0 yd^3
  - Layer 8 – volume of engineered fill: 2,752 yd^3
  - Layer 3 – volume of sand: 764 yd^3
  - Layer 3 – area of geotextile: 3,982 yd^2
  - Layer 2 – volume of silt: 2,241 yd^3
  - Layer 1 – volume of silt and pea gravel mixture: 1,956 yd^3
  - Side slope – volume gravel filter: 346 yd^3
  - Side slope – volume ballast: 346 yd^3
  - Side slope – volume fractured basalt and silt: 970 yd^3.
- The planning costs for the layers are as follows:
  - Pre-level: $0
  - Layer 8 engineered fill: $29,808
  - Layer 3 sand: $38,098
  - Layer 2 silt: $19,915
  - Layer 1 silt and pea gravel: $17,382
  - Side slope: $73,345
  - Silt pit process operations: $21,897.

- Other items of work that are involved in the construction of the barrier are construction survey/elevation control, soils compaction testing, site cleanup, construction of a site fence, and FH RCT support. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.

  - Planning cost for surveying: $16,155
  - Planning cost for soils compaction testing: $4,736
  - Planning cost for miscellaneous cleanup: $1,642
  - Planning cost for site fence: $4,831
  - RCT support for construction cost: $1,973.

- Site revegetation is part of site work. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site cap, construction staging areas, and temporary access roads.

  - Total area to be revegetated: 4 acres
  - Planning cost for reseeding: $2,776
  - Planning cost for planting sagebrush: $3,859
  - Planning cost for Irrigation: $19,748.

Fixed-Price Contractor Field Management: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. The activity is considered a lump sum cost to the project.

- Duration of project: 38 days
- Planning cost for field management: $125,922
- Planning cost for final D&D report: $10,020.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.4.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. The activity is considered a lump sum cost to the project.

- Duration of project management: 38 days
- Project management cost: $68,111
- Planning cost for final D&D report: $2,019.

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)
  - Area of cap system = 25,167 ft^2 = 1 acre (minimum)
  - Team hours to complete inspections = 0.87 day (1 day for every 50,000 ft^2)
  - Daily inspection rate (2 technicians) = \$896/day (\$56/h/person)
  - Barrier cover inspection of surface soil = \$896 x 0.87 day = \$781/event
  - Radiation surveys of surface soil = \$1,000 for every 5,000 ft^2 = \$8,712/event

- Cap maintenance (footprint of cap system)
  - Area of cap system = 1 acre(minimum)
  - Area requiring repair (10% of total area) = 848 yd^2
  - Volume of cap repair (2 ft) = 568 yd^3
  - Oversight (soil placement 130 yd^3/h) = 0.5 day
  - Oversight (vegetation 5,000 yd^2/h) = 0.2 day.

Oversight will be performed by one FH engineer at \$60/h.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section F3.1.4.

F3.4.6 Representative Waste Site 216-A-36B Crib

The site work is estimated to take 96 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown. The construction process will use one crew to perform the work.

- Mobilization: 15 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites

- Capping: 69 days

- Revegetation: 2 days

- Demobilize: 10 days.

Total construction duration = 96 days = 19 weeks = 4.6 months.

Site Description: The basis for the following information can be found in Table F-1.

- Area of waste site contamination: 500 ft x 11 ft = 5,500 ft^2
- Area of waste site with 20-ft overlap: (500+(20x2)) x (11+(20x2)) = 27,540 ft^2
- Type of cap: Hanford
- Side slope of cap: 3:1
- Depth of pre-leveling required: 0 ft
- Depth of cap: 17.8 ft
- Horizontal side slope distance: 70.7 ft
- Cap footprint length: (500+((20+70.7)x2)) = 681.4 ft
- Cap footprint width: (11+((20+70.7)x2)) = 192.4 ft
- Area of cap footprint: 681.4 x 192.4 = 131,101 ft^2.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories. Typical heavy equipment mobilized to and demobilized from the site is as follows:

- Two 250- to 350-hp dozers
- Two LPG dozers
- Two 4- to 5-yd^3 wheel loaders
- Soil vib rollers
- Two off-highway dump trucks
- Pug mill with hoppers and belt loaders
- Two farm tractors
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $25,270 to mobilize and to demobilize.

Contractor personnel are given training before the start of work at the site. The cost of training is planned at $14,977. The training will meet site requirements to work at a waste site.

The contractor will set up or construct a temporary staging area, office trailers, change trailer, and storage container at a cost of $20,768. The rental cost of the trailers and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $36,599. The staging area and roads will be scarified as part of demobilization and the planning cost is $688. The office trailers and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site is $10,556 to construct and $1,631 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $11,869 and is based on the area of the waste site.

Fluor Hanford Sampling and Crew Support: FH will perform all sampling required.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 11 samples
- FH sampling crew: 22 hours
- Air-sampling cost: $6,994.

Site Work:

- Installation of cap: Site 216-A-36B Crib requires a Hanford Barrier. The design, construction, and production rates for the barrier are discussed above in the General Assumptions. These areas and volumes will be used for the cost estimates:
  - Area (footprint) of cap: 131,101 ft^2
  - Pre-level volume: 0 yd^3
  - Layer 9 – volume of engineered fill: 15,982 yd^3
  - Layer 8 – volume of crush gravel base: 1,598 yd^3
  - Layer 7 – volume of low permeability asphalt concrete pavement: 2,385 yd^3
  - Layer 6 – volume of drainage gravel: 2,207 yd^3
  - Layer 5 – volume of fracture basalt: 29,380 yd^3 (includes side slope)
  - Layer 4 – volume of gravel filter: 2,243 yd^3
  - Layer 3 – volume of sand: 1,011 yd^3
  - Layer 3 – area of geotextile: 5,276 yd^2
  - Layer 2 – volume of silt: 4,282 yd^3
  - Layer 1 – volume of silt and pea gravel mixture: 5,400 yd^3
- The planning costs for the layers are as follows:
  - Pre-level: $0
  - Layer 9 engineered fill: $183,008
  - Layer 8 crush gravel base: $59,768
  - Layer 7 low permeability asphalt concrete pavement: $399,270
  - Layer 6 drainage gravel: $17,969
  - Layer 5 fracture basalt: $1,244,925
  - Layer 4 gravel filter: $276,089
  - Layer 3 sand: $24,826
  - Layer 2 silt: $42,921
  - Layer 1 silt and pea gravel: $35,630
  - Gravel and silt pit operations and processing: $63,706.

- Other items of work that are involved in the construction of the barrier are construction survey/elevation control, soils compaction testing, site cleanup, construction of a site fence, and FH RCT support. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.
  - Planning cost for surveying: $49,455
  - Planning cost for soils compaction testing: $13,238
  - Planning cost for miscellaneous cleanup: $1,642
  - Planning cost for site fence: $8,586
  - RCT support for construction cost: $20,302
- Site revegetation is part of site work. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site cap, construction staging areas, and temporary access roads.
  - Total area to be revegetated: 6.7 acres
  - Planning cost for reseeding: $4,858
  - Planning cost for planting sagebrush: $6,753
  - Planning cost for irrigation: $34,559.

Fixed-Price Contractor Field Management: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. The activity is considered a lump sum cost to the project.

- Duration of project: 96 days
- Planning cost for field management: $318,120
- Planning cost for final D&D report: $10,020.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.4.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. The activity is considered a lump sum cost to the project.

- Duration of project management: 96 days
- Project management cost: $172,072
- Planning cost for final D&D report: $2,019.

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)
  - Area of cap system = 131,101 ft^2 = 3 acres
  - Team hours to complete inspections = 2.6 days (1 day for every 50,000 ft^2)
  - Daily inspection rate (2 technicians) = $896/day ($56/h/person)
  - Barrier cover inspection of surface soil = $896 x 2.6 days = $2,330/event
  - Radiation surveys of surface soil = $1,000 for every 5,000 ft^2 = $26,136/event
- Cap maintenance (footprint of cap system)
  - Area of cap system = 3 acres
  - Area requiring repair (10% of total area) = 1,452 yd^2
  - Volume of cap repair (2 ft) = 973 yd^3
  - Oversight (soil placement 130 yd^3/h) = 6.5 day
  - Oversight (vegetation 5,000 yd^2/h) = 0.3 day.

Oversight will be performed by one FH engineer at $60/h.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section F3.1.4.

F3.4.7 Representative Waste Site 207-A South Retention Basin

The site work is estimated to take 37 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown. The construction process will use one crew to perform the work.

- Mobilization: 15 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites
- Capping: 11 days
- Revegetation: 1 day
- Demobilize: 10 days.

Total construction duration = 37 days = 7.4 weeks = 1.8 months.

Site Description: The basis for the following information can be found in Table F-1.

- Area of waste site contamination: 133 ft x 95 ft = 12,635 ft^2
- Area of waste site with 20-ft overlap: (133+(20x2)) x (95+(20x2)) = 23,355 ft^2
- Type of cap: ET Capillary
- Side slope of cap: 3:1
- Depth of pre-leveling required: 7 ft
- Depth of cap: 5.5 ft
- Horizontal side slope distance: 22.8 ft
- Cap footprint length: (133+((20+22.8)x2)) = 218.6 ft
- Cap footprint width: (95+((20+22.8)x2)) = 180.6 ft
- Area of cap footprint: 218.6 x 180.6 = 39,479 ft^2.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories.

Typical heavy equipment mobilized to and demobilized from the site is as follows:

- Large dozer
- Two LPG dozers
- 2- to 3-yd^3 excavator
- Two 4- to 5-yd^3 wheel loaders
- Soil vib rollers
- Two off-highway dump trucks
- Pug mill with hoppers and belt loaders
- Two farm tractors
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $25,270 to mobilize and to demobilize.

Contractor personnel are given training before the start of work at the site. The cost of training is planned at $9,440. The training will meet site requirements to work at a waste site.

The contractor will set up or construct a temporary staging area, office trailers, change trailer, and storage container at a cost of $13,216. The rental cost of the trailers and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $8,605. The staging area and roads will be scarified as part of demobilization and the planning cost is $688. The office trailers and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site is \$5,892 to construct and \$910 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is \$2,967 and is based on the area of the waste site.

Fluor Hanford Sampling and Crew Support: FH will perform all sampling required.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 3 samples
- Quarterly environmental permit samples: 4 samples
- FH sampling crew: 14 hours
- Air-sampling cost: \$5,052.

Site Work:

- Installation of cap: Site 207-A-South Retention Basin requires an ET Capillary Barrier. The design, construction, and production rates for the barrier are discussed above in the General Assumptions. These areas and volumes will be used for the cost estimates:
  - Area (footprint) of cap: 39,479 ft^2
  - Pre-level volume: 1,288 yd^3
  - Layer 8 – volume of engineered fill: 2,326 yd^3
  - Layer 3 – volume of sand: 649 yd^3
  - Layer 3 – area of geotextile: 3,382 yd^2
  - Layer 2 – volume of silt: 1,915 yd^3
  - Layer 1 – volume of silt and pea gravel mixture: 1,693 yd^3
  - Side slope – volume gravel filter: 278 yd^3
  - Side slope – volume ballast: 278 yd^3
  - Side slope – volume fractured basalt and silt: 780 yd^3
- The planning costs for the layers are as follows:
  - Pre-level: \$13,266
  - Layer 8 engineered fill: \$25,194
  - Layer 3 sand: \$32,364
  - Layer 2 silt: \$20,083
  - Layer 1 silt and pea gravel: \$17,552
  - Side slope: \$18,956
  - Silt pit process operations: \$18,956.

- Other items of work that are involved in the construction of the barrier are construction survey/elevation control, soils compaction testing, site cleanup, construction of a site fence, and FH RCT support. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.
  - Planning cost for surveying: $15,496
  - Planning cost for soils compaction testing: $5,101
  - Planning cost for miscellaneous cleanup: $1,642
  - Planning cost for site fence: $3,926
  - RCT support for construction cost: $14,866.
- Site revegetation is part of site work. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site cap, construction staging areas, and temporary access roads.
  - Total area to be revegetated: 4 acres
  - Planning cost for reseeding: $2,776
  - Planning cost for planting sagebrush: $3,859
  - Planning cost for Irrigation: $19,748.

Fixed-Price Contractor Field Management: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. The activity is considered a lump sum cost to the project.

- Duration of project: 37 days
- Planning cost for field management: $122,608
- Planning cost for final D&D report: $10,020.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.4.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. The activity is considered a lump sum cost to the project.

- Duration of project management: 37 days
- Project management cost: $66,319
- Planning cost for final D&D report: $2,019.

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)
  - Area of cap system = 39,479 ft^2 = 1 acre (minimum)
  - Team hours to complete inspections = 0.87 day (1 day for every 50,000 ft^2)
  - Daily inspection rate (2 technicians) = \$896/day (\$56/h/person)
  - Barrier cover inspection of surface soil = \$896 x 0.87 day = \$781/event
  - Radiation surveys of surface soil = \$1,000 for every 5,000 ft^2 = \$8,712/event

- Cap maintenance (footprint of cap system)
  - Area of cap system = 1 acre (minimum)
  - Area requiring repair (10% of total area) = 848 yd^2
  - Volume of cap repair (2 ft) = 568 yd^3
  - Oversight (soil placement 130 yd^3/h) = 0.5 day
  - Oversight (vegetation 5,000 yd^2/h) = 0.2 day.

Oversight will be performed by one FH engineer at \$60/h.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section F3.1.4.

F3.4.8 Representative Waste Site 216-A-37-1 Crib

The site work is estimated to take 45 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown. The construction process will use one crew to perform the work.

- Mobilization: 15 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites

- Capping: 18 days

- Revegetation: 2 days

- Demobilize: 10 days.

Total construction duration = 45 days = 9 weeks = 2.1 months.

Site Description: The basis for the following information can be found in Table F-1.

- Area of waste site contamination: 700 ft x 10 ft = 7,000 ft^2
- Area of waste site with 20-ft overlap: (700+(20x2)) x (10+(20x2)) = 37,000 ft^2
- Type of cap: ET Capillary
- Side slope of cap: 3:1
- Depth of pre-leveling required: 0 ft
- Depth of cap: 5.5 ft
- Horizontal side slope distance: 22.8 ft
- Cap footprint length: (700+((20+22.8)x2)) = 785.6 ft
- Cap footprint width: (10+((20+22.8)x2)) = 95.6 ft
- Area of cap footprint: 785.6 x 95.6 = 75,103 ft^2.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories.

Typical heavy equipment mobilized to and demobilized from the site is as follows:

- Large dozer
- Two LPG dozers
- 2- to 3-yd^3 excavator
- Two 4- to 5-yd^3 wheel loaders
- Soil vib rollers
- Two off-highway dump trucks
- Pug mill with hoppers and belt loaders
- Two farm tractors
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $25,270 to mobilize and to demobilize.

Contractor personnel are given training before the start of work at the site. The cost of training is planned at $9,440. The training will meet site requirements to work at a waste site.

The contractor will set up or construct a temporary staging area, office trailers, change trailer, and storage container, at a cost of $13,216. The rental cost of the trailers and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $8,605. The staging area and roads will be scarified as part of demobilization and the planning cost is $688. The office trailers and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site is $10,630 to construct and $1,643 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $5,934 and is based on the area of the waste site.

Fluor Hanford Sampling and Crew Support: FH will perform all sampling required.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 3 samples
- Quarterly environmental permit samples: 4 samples
- FH sampling crew: 14 hours
- Air-sampling cost: $5,052.

Site Work:

- Installation of cap: Site 216-A-37-1 Crib requires an ET Capillary Barrier. The design, construction, and production rates for the barrier are discussed above in the General Assumptions. The following areas and volumes will be used for the cost estimates:

  - Area (footprint) of cap: 75,103 ft^2
  - Pre-level volume: 0 yd^3
  - Layer 8 – volume of engineered fill: 4,253 yd^3
  - Layer 3 – volume of sand: 1,160 yd^3
  - Layer 3 – area of geotextile: 6,050 yd^2
  - Layer 2 – volume of silt: 3,333 yd^3
  - Layer 1 – volume of silt and pea gravel mixture: 2,783 yd^3
  - Side slope – volume gravel filter: 635 yd^3
  - Side slope – volume ballast: 635 yd^3
  - Side slope – volume fractured basalt and silt: 1,774 yd^3.

- The planning costs for the layers are as follows:

  - Pre-level: $0
  - Layer 8 engineered fill: $46,066
  - Layer 3 sand: $57,860
  - Layer 2 silt: $34,914
  - Layer 1 silt and pea gravel: $28,911
  - Side slope: $134,273
  - Silt pit process operations: $31,156.

- Other items of work that are involved in the construction of the barrier are construction survey/elevation control, soils compaction testing, site cleanup, construction of a site fence, and FH RCT support. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.

- Planning cost for surveying: $19,452
- Planning cost for soils compaction testing: $6,922
- Planning cost for miscellaneous cleanup: $1,642
- Planning cost for site fence: $8,664
- RCT support for construction cost: $3,025.

- Site revegetation is part of site work. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site cap, construction staging areas, and temporary access roads.

  - Total area to be revegetated: 6 acres
  - Planning cost for reseeding: $4,164
  - Planning cost for planting sagebrush: $5,788
  - Planning cost for irrigation: $29,622.

Fixed-Price Contractor Field Management: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. The activity is considered a lump sum cost to the project.

- Duration of project: 45 days
- Planning cost for field management: $149,118
- Planning cost for final D&D report: $10,020.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.4.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. The activity is considered a lump sum cost to the project.

- Duration of project management: 45 days
- Project management cost: $80,658
- Planning cost for final D&D report: $2,019.

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)
  - Area of cap system = 75,103 ft^2 = 1.7 acres
  - Team hours to complete inspections = 1.48 days (1 day for every 50,000 ft^2)
  - Daily inspection rate (2 technicians) = $896/day ($56/h/person)
  - Barrier cover inspection of surface soil = $896 x 1.48 days = $1,326/event
  - Radiation surveys of surface soil = $1,000 for every 5,000 ft^2 = $14,810/event

- Cap maintenance (footprint of cap system)
  - Area of cap system = 1.7 acres
  - Area requiring repair (10% of total area) = 823 yd^2
  - Volume of cap repair (2 ft) = 551 yd^3
  - Oversight (soil placement 130 yd^3/h) = 4.2 days
  - Oversight (vegetation 5,000 yd^2/h) = 0.2 day.

Oversight will be performed by one FH engineer at $60/h.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section F3.1.4.

F3.4.9 Sites with Special Conditions

Site UPR-200-E-64: This site does not require the same design of barriers described above. A Biological Barrier design is planned for this site. The construction of the barrier is described in Section F3.4.1.14.

The site work is estimated to take 38 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown. The construction process will use one crew to perform the work.

- Mobilization: 10 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites

- Capping: 17 days

- Revegetation: 1 day
- Demobilize: 10 days.

Total construction duration = 38 days = 8 weeks = 1.8 months.

Site Description: The basis for the following information can be found in Table F-1.

- Area of waste site contamination: 295 ft x 295 ft = 87,025 ft^2
- Area of waste site with 20-ft overlap: (295+(20x2)) x (295+(20x2)) = 112,225 ft^2
- Type of cap: Biological
- Side slope of cap: 3:1
- Depth of pre-leveling required: 0 ft
- Depth of cap: 5 ft
- Horizontal side slope distance: 21 ft
- Cap footprint length: (295+((20+21)x2)) = 377 ft
- Cap footprint width: (295+((20+21)x2)) = 377 ft
- Area of cap footprint: 377 x 377 = 142,129 ft^2.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories.

Typical heavy equipment mobilized to and demobilized from the site is as follows:

- Large dozer
- Two LPG dozers
- Two 4- to 5-yd^3 wheel loaders
- Soil vib rollers
- Two off-highway dump trucks
- Pug mill with hoppers and belt loaders
- Two farm tractors
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $25,270 to mobilize and to demobilize.

Contractor personnel are given training before the start of work at the site. The cost of training is planned at $9,440. The training will meet site requirements to work at a waste site.

The contractor will set up or construct a temporary staging area, office trailers, change trailer, and storage container at a cost of $9,440. The rental cost of the trailers and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $8,605. The staging area and roads will be scarified as part of demobilization and the planning cost is $688. The office trailers and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site is $9,436 to construct and $1,458 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $11,869 and is based on the area of the waste site.

Fluor Hanford Sampling and Crew Support: FH will perform all sampling required.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 12 samples
- Quarterly environmental permit samples: 4 samples
- FH sampling crew: 32 hours
- Air-sampling cost: $11,548.

Site Work:

- Installation of cap: Site UPR-200-E-64 requires an ET Capillary Barrier. The design, construction, and production rates for the barrier are discussed above in the General Assumptions. These areas and volumes will be used for the cost estimates:
  - Area (footprint) of cap: 142,129 ft^2
  - Pre-level volume: 0 yd^3
  - Layer 8 – volume of engineered fill: 17,348 yd^3
  - Layer 1 – volume of silt and pea gravel mixture: 7,850 yd^3.
- The planning costs for the layers are as follows:
  - Pre-level: $0
  - Layer 8 engineered fill: $178,681
  - Layer 1 silt and pea gravel: $75,333
  - Silt pit process operations: $87,863.
- Other items of work that are involved in the construction of the barrier are construction survey/elevation control, soils compaction testing, site cleanup, construction of a site fence, and FH RCT support. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.
  - Planning cost for surveying: $5,275
  - Planning cost for soils compaction testing: $3,643
  - Planning cost for miscellaneous cleanup: $1,642
  - Planning cost for site fence: $7,485
  - RCT support for construction cost: $1,184.

- Site revegetation is part of site work. This work covers the seeding of native dry land grasses, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site cap, construction staging areas, and temporary access roads.
  - Total area to be revegetated: 7 acres
  - Planning cost for reseeding: $4,858
  - Planning cost for Irrigation: $34,559.

Fixed-Price Contractor Field Management: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. The activity is considered a lump sum cost to the project.

- Duration of project: 38 days
- Planning cost for Field management: $125,922
- Planning cost for final D&D report: $10,020.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.4.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. The activity is considered a lump sum cost to the project.

- Duration of project management: 38 days
- Project management cost: $68,111
- Planning cost for final D&D report: $2,019.

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)

– Area of cap system	= 142,129 ft^2 = 3.3 acres
– Team hours to complete inspections	= 2.87 days (1 day for every 50,000 ft^2)
– Daily inspection rate (2 technicians)	= $896/day ($56/h/person)
– Barrier cover inspection of surface soil	= $896 x 2.87 days = $2,576/event
– Radiation surveys of surface soil	= $1,000 for every 5,000 ft^2 = $28,750/event

- Cap maintenance (footprint of cap system)
  - Area of cap system = 3.3 acres
  - Area requiring repair (10% of total area) = 1,597 yd^2
  - Volume of cap repair (2 ft) = 1,070 yd^3
  - Oversight (soil placement 130 yd^3/h) = 8.2 days
  - Oversight (vegetation 5,000 yd^2/h) = 0.3 day.

Oversight will be performed by one FH engineer at $60/h.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section F3.1.4.

Site 270-E-1 Neutralization Tank: This is a large underground steel tank with a large-diameter riser extending to the surface. The tank was filled with limestone during operation of the adjoining facility. It is expected that limestone is still present in the tank and that it is filled to the discharge level of the tank. The riser is empty from the discharge pipe to the ground surface. To prevent collapse of the riser in the future, the void space will be pumped full of control density fill or grout before barrier construction.

Site 200-E-58 Neutralization Tank: This tank will be handled the same as the 270-E-1 Neutralization Tank.

Sites 203-S Basin, 204-S Basin, 205-S Building Foundation, 205-S Vault: The four sites are close together and are all covered by the same area as 200-W-22 Site Group. An ET Capillary Barrier is planned for UPR-200-W-22, so a barrier will not be required for the four sites.

Sites 216-A-20 Trench and 216-A-20 Trench Overflow: The 216-A-20 Trench and the 216-A-20 Trench Overflow are located in the same area. Because the overflow is the larger of the two sites, a barrier will be planned for this site only.

F3.5 ALTERNATIVE 5 – PARTIAL REMOVAL, TREATMENT, AND DISPOSAL WITH CAPPING

ET Capillary Barriers will be constructed over certain trenches, ponds, or cribs after the site has been excavated to remove contaminated soil to a depth required for intruder protection. For planning purposes, the side overlap for this type of barrier will be 20 ft for all exterior sides.

F3.5.1 General Assumptions

The general assumptions for Alternative 5 are as follows.

F3.5.1.1 Fieldwork such as mobilization/demobilization, waste site excavation, backfill, borrow site excavation, barrier fill, revegetation, and some of the post-construction work will be contracted to an FP contractor. The project management, RCT support, sampling, and safety oversight will be performed by FH. The waste disposal work involved with hauling from the site to ERDF and ERDF dumping cost/fees will be performed by the environmental restoration contractor responsible for ERDF.

F3.5.1.2 Mobilization and startup include site training; mobilization of equipment and personnel; installation of temporary construction fences; construction of access roads; setting up office, change, and storage trailers with utilities; construction of staging/container storage areas and access roads, truck scales, temporary survey buildings, and decontamination areas.

F3.5.1.3 The excavation sites will have contaminated waste removed to a specified depth. The sides of the excavation will be sloped at 1:1.5 to the bottom of the excavation except for those sites that originally were constructed using 2:1 slopes. During the removal process, heavy equipment will be kept out of the excavation site.

F3.5.1.4 For excavation sites, overburden will be removed with a 2- to 3-yd^3 excavator and two haul trucks. The soil will be stockpiled near by the waste site. A highway truck with a water tank trailer is used to control dust during this activity. The production rate for one crew is 127 yd^3/h.

F3.5.1.5 Contaminated waste will be excavated using a 2- to 3-yd^3 hydraulic crawler excavator. The contaminated soil will be directly placed into lined ERDF containers and hauled from the excavation site. A highway truck with a water tank trailer is used to control dust during this activity. Depending on the volume of waste to move, one to four crews can be working at a site. Crew labor consists of one operator, one laborer, and one truck driver. The production rate for one crew is 55 yd^3/h. An FH RCT supports the work at 1½ hours per excavation crew hour.

F3.5.1.6 Air sampling will be performed during the excavation of contaminated soil. A minimum of two samples will be taken per day. The planning cost per sample is $520. The sampling crew consists of one sampler and one RCT.

F3.5.1.7 Soil samples will be taken of the overburden, from ERDF containers, and for verification that the completion of the excavation. The soil-sampling cost developed as follows:

- Noncontaminated soil sampling
  - Maximum of 6 samples or 1 sample/yd^3, whichever is less
  - QA samples required: 1
  - The planning cost per sample is $1,262/sample.
  - The soil being sampled is the overburden that is uncontaminated and will not be removed from the site.

- Sampling required for waste going to ERDF:
  - One sample is required for every 70 containers.
  - There will be a minimum of 6 samples per site.
  - QA samples required: a minimum of 1 or 5 percent of total of ERDF samples, whichever is greater.
  - The planning cost per sample is $452/sample.
- Pre–verification process sampling
  - One sample will be required per 2,500 m^2 (50m x 50m)(26,899 ft^2)
  - There will be a minimum of six samples per site.
  - QA samples required: a minimum of 2 or 5 percent of total the samples, whichever is greater
  - The planning cost per sample is $2,227/sample.
  - These samples are the preliminary samples needed to see if all of the required waste has been removed from a site being excavated.
  - This process is expected to happen twice during the excavation process.
  - If the samples show that the site has met the requirement, then the verification process will start.
- Verification process sampling
  - One sample will be required per 625 m^2 (25 m x 25 m)(6,724 ft^2).
  - There will be a minimum of six samples per site.
  - QA samples required: a minimum of 2 or 5 percent of total the samples, whichever is greater
  - The planning cost per sample is $7,856/sample for onsite laboratory analysis and $1,458 for offsite laboratory analysis and shipping (based on six samples being processed at one time), for a total of $9,314/sample.
  - These samples are the final samples needed to see if all of the required waste has been removed from a site being excavated.
  - This process happens once during the excavation process.

- Sampling crews
  - Verification sampling – 1 hour for each sample taken by a crew consisting of one FH RCT and one sampler technician.
  - Other sampling (air, ERDF, noncontaminated) – 1 hour for each sample taken by a crew consisting of one FH RCT and a sampler technician.

F3.5.1.8 The ERDF container handling and loading process starts with a site haul truck picking up an empty container at the staging area. The container is moved to a preparation area where laborers install a bed liner and it is inspected by a one-half time RCT. The haul truck and container proceed to the loading area. After loading, the liner is sealed and the container is secured by laborers. The container is moved to the survey building where three RCTs inspect and survey the container and truck for contamination. From there, the haul truck and container are weighed on a platform scale and then driven to the storage area. The container is unloaded from the truck at the storage area. Three trucks are required to support each contaminated excavation crew.

F3.5.1.9 The ERDF disposal fee and transportation and handling costs are estimated at $980 per container. An environmental restoration contractor driver and truck/trailer will move a loaded container to ERDF and place an empty container in the staging area. The estimated costs include the rental of the containers used. For planning purposes, the capacity of an ERDF container is 11 bulk yd^3 or 12.7 loose yd^3 of contaminated waste.

F3.5.1.10 Backfilling is performed by three different operations:

- The moving of the stockpiled overburden back to the excavation site will require one crew. The equipment used by a crew is one 4- to 5-yd^3 loader and two haul trucks. Labor is one operator and two truck drivers. The production rate for one crew is 185 yd^3/h.
- The moving of borrow material to the excavation site typically is performed by one crew hauling from an onsite pit source. The equipment used by a crew is one 4- to 5-yd^3 loader, six 20-yd^3 highway truck/trailers, and one water truck. Labor is one operators and seven truck drivers. The production rate for one crew is 185 yd^3/h.
- Spreading and compaction of the backfill at the site is performed by one crew. The equipment used per crew is one 300-hp dozer and one 6,000-gal water truck/trailer. Labor consists of one operator, one truck driver, and one laborer. The production rate for one crew is 185 yd^3/h.

F3.5.1.11 There are two onsite sources for the fill materials to construct the three soil/fill layers. The source for engineered fill is located at Pit 30 approximately halfway between the 200 East and 200 West Areas. This pit is assumed to have the sufficient quantity for this project. The source for the silt required for Layers 1 and 2 is located at Area C about 2 miles south of the 200 West Area.

F3.5.1.12 The sand will be supplied an offsite vendor or from a commercial gravel pit. The sand will be delivered to the waste site by the vendor.

F3.5.1.13 Sites are considered level and will not require pre-leveling before the start of construction of the barrier.

F3.5.1.14 The ET Capillary Barrier will consist of four different layers.

- The bottom layer will be constructed of 20 in. of engineered fill. The construction of the engineered fill requires the excavation of suitable borrow from an onsite pit source. The estimated time to complete the fill is based on the production rate of a 4- to 5-yd^3 loader excavating at the pit. All material is screened with a grizzly mounted on a surge bin to remove 4–in. or larger rocks. The six semi-tractor trucks with 20 yd^3 bottom dump trailer trailers are needed to keep up with the loader. A truck with a 6,000-gal water trailer provides dust control at the pit. The production rate for this work is 185 loose yd^3/h. The spreading and compaction equipment used at the barrier is a 250- to 300-hp dozer with a U-blade to spread fill, and two 12-ton vib tandem rollers. A truck with a 6,000-gal water trailer provides dust control.

- To produce a smooth surface to prevent low areas, the surface of engineered fill is fine graded. Work involves a 100- to 150-hp dozer with laser controls, a 4- to 5-yd^3 loader, one 12-ton vib single drum roller, and a water tanker. The production rate is 2,500 yd^2/h for the engineered fill surface area. One laborer supports the dozer operator and the water truck driver. Two engineer technicians set up the grade and elevation control.

- The third layer will be constructed of 6 in. of sand covered with geotextile. Work covers the spreading, compacting, and fine grading of the filter sand used for Layer 3. The delivered cost of material, based on vendor quotes, is \$16.70/yd^3. The equipment used to construct this layer is a motor grader, two 12-ton vib tandem rollers, and a truck with a 6,000-gal water trailer. Production rate for this work is 208 yd^3/h. Three equipment operators and one truck driver operate the equipment. One laborer supports the grader operator as a grade checker and helps unload trucks.

- Layer 3 will be fine graded to produce a smooth surface before placement of the geotextile. Work involves a 100- to 150-hp dozer with laser controls, a 4- to 5-yd^3 loader, one 12-ton vib single drum roller, and a water tanker. The production rate is 2,500 yd^2/h for the engineered fill surface area. One laborer supports the dozer operator and the water truck driver. Two engineer technicians set up the grade and elevation control.

- A geotextile is placed on top of Layer 3. This item of work covers the placement of needle-punched 120 mil polypropylene geotextile over the sand filter layer. The production rate is 150 yd^2/h. Three laborers place and splice the fabric.

- The second layer will be constructed of 20 in. of silt fill. The construction of the layer involves excavating and hauling the silt from the onsite pit to the barrier. The production rate is based on a 4- to 5-yd^3 loader excavating and loading at the pit. Seven trucks are 20-yd^3 bottom dump trailer and semi-tractor combinations. The production rate for this work is 185 loose yd^3/h based on the production of the loader. At the barrier, the silt is spread with a 200- to 250-hp low-ground-pressure dozer. The silt is scarified to prevent overcompaction. Trucks with 6,000-gal water trailers provide dust control at the pit and the barrier.

- The top layer will be constructed of silt/pea gravel fill material. Layer 1 requires a 20-in.-deep layer of fill material consisting of silt with 15 percent pea gravel added by weight. The silt is excavated with a 4- to 5-yd^3 loader and hauled from the site silt source by two dump trucks to a process area near the pit. Pea gravel from a commercial source is delivered and stockpiled at the process area. The delivered cost of material, based on vendor quotes, is \$18.71/yd^3. A 4- to 5-yd^3 loader and a pug mill with belt loader are used to mix the silt and gravel. The hauling from the process area is the same as described for Layer 2. Spreading is the same as Layer 2.

- The side slopes of the barrier will be covered with 1-ft-deep fractured basalt and 1-ft-deep engineered fill.

  - The side slopes of the barrier are graded before placing any ballast, gravel filter, or fractured basalt. The work involves a 100- to 150-hp dozer with laser controls, a 4- to 5-yd^3 loader, one 12-ton vib single drum roller, and a water tanker. The production rate is 2,500 yd^2/h for the engineered fill surface area. One laborer supports the dozer operator and the water truck driver. Two engineer technicians set up the grade and elevation control.

  - The construction of the ballast and the gravel filter for the side slope follows the grading of the side slope. A truck with a water trailer provides dust control. The production rate for this work is 125 loose yd^3/h. The spreading and compaction equipment used at the barrier to spread fill is a 4- to 5-yd^3 loader, a 100- to 150-hp dozer with laser controls, and one 12-ton vib single drum roller. One laborer supports the dozer operator and the water truck driver. Both gravel layers are 6 in. deep. The ballast and the gravel filter will come from a commercial source and will be delivered and stockpiled at the construction site. The delivered cost for ballast is \$19.98/yd^3 and \$16.70/yd^3, based on vendor quotes.

  - The fractured basalt with silt layer is the last layer of the side slopes to be constructed. The fractured basalt will come from a commercial source and will be delivered and stockpiled at the construction site. The delivered cost of the rock is based on vendor quotes of \$21.61/yd^3. The silt will come from the same source as Layer 2. The silt will be delivered and stockpiled at the barrier site when the silt for Layer 2 is being hauled. One loader and 300-hp dozer are used to place the basalt on the fill slope. One laborer supports the work. The production rate is 70 loose yd^3/h. A quarter-time water truck and driver are used for dust control.

F3.5.1.15 Instrumentation is not included for this series of barriers.

F3.5.1.16 After completion of the barrier construction work, a 4-ft steel post with chain fence will be built around the site. The fence location is at the toe of the barrier slope.

F3.5.1.17 During the construction of the barrier, compaction testing will be performed on the four layers of fill. The engineered fill and sand layer will require that a minimum level of compaction has been reached. The top two layers will be tested to ensure that the fill does not become overcompacted.

F3.5.1.18 Revegetation of the waste site barrier includes planting native dry land grass using tractors with seed drills and hand broadcasting, hand planting sagebrush seedlings, and irrigation for four times in the spring or early summer. All disturbed areas, such as around the barrier, stockpile, staging areas, and access roads, will be replanted.

F3.5.1.19 The FH Project Management team consists of a part-time project manager with a full-time field supervisor and part-time engineering support. QA, Radiological Control, and Safety also provide oversight along with other support for contract management, and project controls. Total hours for this staff are planned at 22.5 hours per day. The duration of this work is based on total project duration.

F3.5.1.20 The FP contractor field supervisory team consists of a full-time construction manager and field supervisor, along with part-time QA, construction safety, and clerical support. Two pickup trucks are included in the cost. Total hours for this staff are planned at 21 hours per day. The duration of this work is based on total project duration.

F3.5.1.21 Demobilization includes demobilization of equipment and personnel, removal of temporary construction fences, construction of staging/container storage areas, access roads, office/change/storage trailers, truck scales, temporary survey buildings, and decontamination areas.

F3.5.1.22 Waste sites that require TRU waste removal as part of the removal process will follow the process for handling TRU waste as outlined in Section F3.3.1.17.

F3.5.2 Representative Waste Site 216-A-19 Trench (Cost Tables F-14 through F-17)

The site work is estimated to take 37 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown. The RTD process and the barrier construction process will both use one crew to perform the work.

- Mobilization: 10 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites
- Excavate contaminated and uncontaminated soil: 7 days
- Site work, includes backfilling excavation: 3 days
- Capping: 5 days

- Revegetation: 2 days
- Demobilize: 10 days.

Total construction duration = 37 days = 7.4 weeks = 1.8 months.

Site Description: The basis for the following information can be found in Table F-2.

- Area of contamination: 25 ft x 25 ft = 625 ft^2
- Depth of clean overburden: 0 ft bgs
- Total excavated depth: 20 ft bgs
- Volume of contaminated soil to be removed: 3,130 yd^3
- Total excavated volume (2:1 side slopes): 3,130 yd^3
- Volume of clean overburden: 0 yd^3
- Volume of borrow from onsite source: 3,130 yd^3
- Area of waste site with 20-ft overlap: (25+(2x20)) x (25+(2x20)) = 0.28 acres
- Type of cap: ET Capillary
- Side slope of cap: 3:1
- Depth of cap: 5.5 ft
- Horizontal side slope distance: 22.8 ft
- Cap footprint length: (25+((20+22.8)x2)) = 110.6 ft
- Cap footprint width: (25+((20+22.8)x2)) = 110.6 ft
- Area of cap footprint: 110.6 x 110.6 = 12,232 ft^2.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories. Some equipment will be mobilized for the excavation, and different equipment will be mobilized for the cap construction.

Typical excavation (RTD) heavy equipment mobilized to and demobilized from the site per crew is as follows:

- Large dozer
- 2- to 3-yd^3 excavator
- 4- to 5-yd^3 wheel loader
- Two off-highway dump trucks
- Backhoe loader
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Three trucks with tilt container beds.

Typical cap construction heavy equipment mobilized to and demobilized from the site per crew is as follows:

- Large dozer
- Two LPG dozers

- 2- to 3-yd^3 excavator
- Two 4- to 5-yd^3 wheel loaders
- Soil vib rollers
- Two off-highway dump trucks
- Pug mill with hoppers and belt loaders
- Two farm tractors
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $11,725 to mobilize. The cost to demobilize is planned at $23,988, which also includes the decontamination of the equipment included, along with moving the equipment to the storage yard. This includes the FP labor to clean the equipment. The FH RCT labor hours support to decontamination of the construction equipment is 40 hours, which is planned at $2,462.

Contractor personnel are provided training before the start of work at the site. The cost of training is planned at $55,486. The training will meet site requirements to work at a waste site. The typical crews (one for RTD and one for capping) were used to calculate the cost of training.

The contractor will set up or construct a temporary staging area, two office trailers, change trailer, storage container, truck scales, and survey building at a cost of $62,697. The rental cost of the trailers, scales, and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $8,226. Decontamination areas will be set up as part of the site mobilization at a cost of $53,304. The staging area and roads will be scarified as part of demobilization and the planning cost is $862. The decontamination areas also will be removed at a planning cost of $21,020. The office trailers, truck scales, and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site fence is $2,907 to construct and $575 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $865 and is based on the area of the waste site.

Fluor Hanford Sampling and Crew Support: FH will perform all sampling required.

Soil sampling (noncontaminated soil, ERDF certification, pre-verification, verification samples). See Section F3.3.1 for sampling rate and process.

- Noncontaminated samples (includes QA samples): 1 sample
- ERDF certification samples (includes QA samples): 5 samples
- Pre-verification samples (includes QA samples): 16 samples

- Verification samples (includes QA samples): 8 samples
- Soil-sampling cost: $130,499.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 21 samples
- Quarterly environmental permit samples: 4 samples
- Air-sampling cost: $17,313.

Field sampling FH crew support:

- Sampling crew: 74 hours
- Sampling crew cost: $4,635.

Site Work: This activity covers the backfilling of the site with the overburden soil and soil hauled from an onsite borrow source. This activity has three items of work: loading and hauling the overburden, loading and hauling the borrow soil, and spreading backfill at the site. Dust control is included in this work. See Section F3.3.1 for crews and production rates. For this site, four crews will be used due to the amount of overburden and borrow soil to be hauled and spread. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.

- Load/haul overburden volume: 0 yd^3
- Planning cost to load/haul overburden: $0
- Load/haul borrow soil volume: 3,130 yd^3
- Planning cost to load/haul borrow soil: $20,952
- Spread backfill/compaction volume: 3,130 yd^3
- Planning cost to spread backfill/compaction: $4,206
- Miscellaneous cleanup duration: 8 weeks
- Planning cost for miscellaneous cleanup: $1,527.

Site revegetation is part of site restoration. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site, overburden stockpile, staging areas, and access roads.

- Total area to be revegetated: 3 acres
- Planning cost for reseeding: $3,458
- Planning cost for planting sagebrush: $3,855
- Planning cost for irrigation: $18,054.

Soil Excavation:

- Excavation: The work activities covered by Excavation include stripping and stockpiling overburden soil, and excavation of contaminated soil. The contaminated soil will be placed directly into the ERDF containers. The moving of the containers from the excavation site and the processing of the containers are covered in the container loading and handling process description (see below). Dust suppression is included in each

activity. A description of how the work is performed is presented in Section F3.3.1. For this site, four crews will be used due to the amount of overburden and contaminated soil to be removed.

- Overburden soil removed and stockpiled: 0 yd^3
- Planning cost to remove overburden: $0
- Excavation of contaminated soil: 3,130 yd^3
- Planning cost to excavate contaminated soil: $18,518
- RCT support for soil excavation: 47 hours
- RCT excavation support cost: $4,340
- FH industrial safety support: 56 hours
- FH industrial safety cost: $3,819.

- Container loading and handling process: This activity involves installing liners in containers, hauling the containers to a survey area, weighing, and unloading at a temporary storage area. See Section F3.3.1 for details of how the work is performed. For this site, four crews will be used due to the amount of contaminated soil to be handled.

  - Number of ERDF containers hauled, weighed, and processed: 280
  - Planning cost for hauling and securing the containers: $13,691
  - Planning cost for preparing containers for loading: $13,409
  - Planning cost for weighing and storing containers: $6,9741
  - RCT support for queue operations survey: 47 hours
  - RCT support for queue operations planning cost: $1,446
  - RCT support for container radiation surveying: 234 hours
  - RCT support for container radiation surveying planning cost: $8,680.

- ERDF transportation and disposal: The planning cost for disposal and transportation is $980 per container without overhead charges. This cost includes the disposal fee, the transportation cost from the wastes site staging area to ERDF, and the replacement of the loaded container with an empty container at the staging area.

  - Total number of containers required: 280
  - Cost of containers: $318,195.

Installation of Cap: Site 216-A-19 Trench requires an ET Capillary Barrier. The design, construction, and production rates for the barrier are discussed above in the General Assumptions.

The following areas and volumes will be used for the cost estimates:

- Area (footprint) of cap: 12,232 ft^2
- Pre-level volume: 0 yd^3
- Layer 8 –volume of engineered fill: 614 yd^3
- Layer 3 – volume of sand: 160 yd^3
- Layer 3 – area of geotextile: 832 yd^2
- Layer 2 – volume of silt: 435 yd^3

- Layer 1 – volume of silt and pea gravel mixture: 333 yd^3
- Side slope – volume gravel filter: 146 yd^3
- Side slope – volume ballast: 146 yd^3
- Side slope – volume fractured basalt and silt: 413 yd^3
- The planning costs for the layers are as follows:
  - Pre-level: $0
  - Layer 8 engineered fill: $6,253
  - Layer 3 sand: $7,824
  - Layer 2 silt: $4,423
  - Layer 1 silt and pea gravel: $3,308
  - Side slope: $30,873
  - Silt pit process operations: $3,639.
- Other items of work that are involved in the construction of the barrier are construction survey/elevation control, soils compaction testing, site cleanup, construction of a site fence, and FH RCT support.
  - Planning cost for surveying: $11,200
  - Planning cost for soils compaction testing: $1,537
  - RCT support for construction cost: $526.

Construction Staff: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. This activity is considered a lump sum cost to the project.

- Duration of project: 37 days
- Planning cost for field management: $99,397
- Planning cost for final D&D report: $8,920.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.3.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. This activity is considered a lump sum cost to the project. The final site survey by the FH survey team is part of the as-built process and is based on the area of the waste site.

- Duration of project management: 37 days
- Project management cost: $63,115
- Planning cost for final D&D report: $2,019
- Area of final site survey: 1 acre
- Planning cost for final site survey: $1,634.

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities

performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)
  - Area of cap system = 12,232 ft^2 = 1 acre (minimum)
  - Team hours to complete inspections = 0.87 day (1 day for every 50,000 ft^2)
  - Daily inspection rate (2 technicians) = \$896/day (\$56/h/person)
  - Barrier cover inspection of surface soil = \$896 x 0.87 day = \$781/event
  - Radiation surveys of surface soil = \$1,000 for every 5,000 ft^2 = \$8,712/event
- Cap maintenance (footprint of cap system)
  - Area of cap system = 1 acre (minimum)
  - Area requiring repair (10% of total area) = 484 yd^2
  - Volume of cap repair (2 ft) = 324 yd^3
  - Oversight (soil placement 130 yd^3/h) = 0.3 day
  - Oversight (vegetation 5,000 yd^2/h) = 0.1 day.

Oversight will be performed by one FH engineer at \$60/h.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section F3.1.4.

F3.5.3 Representative Waste Site 216-B-12 Crib (Cost Tables F-14 through F-17)

The site work is estimated to take 270 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown. The RTD process and the barrier construction process will both use one crew to perform the work.

- Mobilization: 10 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites
- Excavate contaminated and uncontaminated soil: 164 days
- Site work, includes backfilling excavation: 75 days
- Capping: 9 days

- Revegetation: 2 days
- Demobilize: 10 days.

Total construction duration = 270 days = 54 weeks = 12.8 months.

Site Description: The basis for the following information can be found in Table F-2.

- Area of contamination: 160 ft x 50 ft = 8,000 ft^2
- Depth of clean overburden: 14 ft bgs
- Total excavated depth: 63 ft bgs
- Volume of contaminated soil to be removed: 66,740 yd^3
- Total excavated volume (1.5:1 side slopes): 85,809 yd^3
- Volume of clean overburden: 19,069 yd^3
- Volume of borrow from onsite source: 66,740 yd^3
- Area of waste site with 20-ft overlap: (160+(2x20)) x (50+(2x20)) = 0.41 acre
- Type of cap: ET Capillary
- Side slope of cap: 3:1
- Depth of cap: 5.5 ft
- Horizontal side slope distance: 22.8 ft
- Cap footprint length: (160+((20+22.8)x2)) = 245.6 ft
- Cap footprint width: (50+((20+22.8)x2)) = 135.6 ft
- Area of cap footprint: 245.6 x 135.6 = 33,303 ft^2.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories. Some equipment will be mobilized for the excavation, and different equipment will be mobilized for the cap construction.

Typical excavation (RTD) heavy equipment mobilized to and demobilized from the site per crew is as follows:

- Large dozer
- 2- to 3-yd^3 excavator
- 4- to 5-yd^3 wheel loader
- Two off-highway dump trucks
- Backhoe loader
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Three trucks with tilt container beds.

Typical cap construction heavy equipment mobilized to and demobilized from the site per crew is as follows:

- Large dozer
- Two LPG dozers

- 2- to 3-yd^3 excavator
- Two 4- to 5-yd^3 wheel loaders
- Soil vib rollers
- Two off-highway dump trucks
- Pug mill with hoppers and belt loaders
- Two farm tractors
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $11,725 to mobilize. The cost to demobilize is planned at $23,988, which also includes the decontamination of the equipment included, along with moving the equipment to the storage yard. This includes the FP labor to clean the equipment. The FH RCT labor hours support to decontamination of the construction equipment is 40 hours, which is planned at $2,462.

Contractor personnel are provided training before the start of work at the site. The cost of training is planned at $55,486. The training will meet site requirements to work at a waste site. The typical crews (one for RTD and one for capping) were used to calculate the cost of training.

The contractor will set up or construct a temporary staging area, two office trailers, change trailer, storage container, truck scales, and survey building at a cost of $97,277. The rental cost of the trailers, scales, and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $8,226. Decontamination areas will be set up as part of the site mobilization at a cost of $64,922. The staging area and roads will be scarified as part of demobilization and the planning cost is $862. The decontamination areas also will be removed at a planning cost of $21,020. The office trailers, truck scales, and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site fence is $5,269 to construct and $794 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $865 and is based on the area of the waste site.

Fluor Hanford Sampling and Crew Support: FH will perform all sampling required.

Soil sampling (noncontaminated soil, ERDF certification, pre-verification, verification samples). See Section F3.3.1 for sampling rate and process.

- Noncontaminated samples (includes QA samples): 7 samples
- ERDF certification samples (includes QA samples): 91 samples
- Pre-verification samples (includes QA samples): 16 samples

- Verification samples (includes QA samples): 21 samples
- Soil-sampling cost: $322,836.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 480 samples
- Quarterly environmental permit samples: 12 samples
- Air-sampling cost: $293,729.

Field sampling FH crew support:

- Sampling crew: 609 hours
- Sampling crew cost: $69,468.

Site Work: This activity covers the backfilling of the site with the overburden soil and soil hauled from an onsite borrow source. This activity has three items of work: loading and hauling the overburden, loading and hauling the borrow soil, and spreading backfill at the site. Dust control is included in this work. See Section F3.3.1 for crews and production rates. For this site, four crews will be used due to the amount of overburden and borrow soil to be hauled and spread. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.

- Load/haul overburden volume: 19,069 yd^3
- Planning cost to load/haul overburden: $46,440
- Load/haul borrow soil volume: 66,740 yd^3
- Planning cost to load/haul borrow soil: $446,706
- Spread backfill/compaction volume: 85,809 yd^3
- Planning cost to spread backfill/compaction: $214,614
- Miscellaneous cleanup duration: 63 weeks
- Planning cost for miscellaneous cleanup: $2,631.

Site revegetation is part of site restoration. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site, overburden stockpile, staging areas, and access roads.

- Total area to be revegetated: 4 acres
- Planning cost for reseeding: $4,611
- Planning cost for planting sagebrush: $5,140
- Planning cost for Irrigation: $24,072.

Soil Excavation:

- Excavation: The work activities covered by Excavation include stripping and stockpiling overburden soil, and excavation of contaminated soil. The contaminated soil will be placed directly into the ERDF containers. The moving of the containers from the excavation site and the processing of the containers are covered in the container loading and handling process description (see below). Dust suppression is included in each

activity. A description of how the work is performed is presented in Section F3.3.1. For this site, four crews will be used due to the amount of overburden and contaminated soil to be removed.

- Overburden soil removed and stockpiled: 19,069 yd^3
- Planning cost to remove overburden: $94,028
- Excavation of contaminated soil: 66,740 yd^3
- Planning cost to excavate contaminated soil: $394,804
- RCT support for soil excavation: 1,146 hours
- RCT excavation support cost: $105,823
- FH industrial safety support: 1,312 hours
- FH industrial safety cost: $89,494.

- Container loading and handling process: This activity involves installing liners in containers, hauling the containers to a survey area, weighing, and unloading at a temporary storage area. See Section F3.3.1 for details of how the work is performed. For this site, four crews will be used due to the amount of contaminated soil to be handled.

  - Number of ERDF containers hauled, weighed, and processed: 5,964
  - Planning cost for hauling and securing the containers: $542,691
  - Planning cost for preparing containers for loading: $529,630
  - Planning cost for weighing and storing containers: $275,334
  - RCT support for queue operations survey: 995 hours
  - RCT support for queue operations planning cost: $30,626
  - RCT support for container radiation surveying: 2,985 hours
  - RCT support for container radiation surveying planning cost: $183,759.

- ERDF transportation and disposal: The planning cost for disposal and transportation is $980 per container without overhead charges. This cost includes the disposal fee, the transportation cost from the wastes site staging area to ERDF, and the replacement of the loaded container with an empty container at the staging area.

  - Total number of containers required: 5,964
  - Cost of containers: $6,713,480.

Installation of Cap: Site 216-B-12 Crib requires an ET Capillary Barrier. The design, construction, and production rates for the barrier are discussed above in the General Assumptions.

The following areas and volumes will be used for the cost estimates:

- Area (footprint) of cap: 33,303 ft^2
- Pre-level volume: 0 yd^3
- Layer 8 – volume of engineered fill: 1,910 yd^3
- Layer 3 – volume of sand: 526 yd^3
- Layer 3 – area of geotextile: 2,745 yd^2

- Layer 2 – volume of silt: 1,533 yd^3
- Layer 1 – volume of silt and pea gravel mixture: 1,323 yd^3
- Side slope – volume gravel filter: 264 yd^3
- Side slope – volume ballast: 264 yd^3
- Side slope – volume fractured basalt and silt: 743 yd^3
- The planning costs for the layers are as follows:

  - Pre-level: $0
  - Layer 8 engineered fill: $19,452
  - Layer 3 sand: $25,756
  - Layer 2 silt: $14,652
  - Layer 1 silt and pea gravel: $12,634
  - Side slope: $55,628
  - Silt pit process operations: $14,439.

- Other items of work that are involved in the construction of the barrier are construction survey/elevation control, soils compaction testing, site cleanup, construction of a site fence, and FH RCT support.

  - Planning cost for surveying: $13,263
  - Planning cost for soils compaction testing: $3,294
  - RCT support for construction cost: $0.

Construction Staff: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. This activity is considered a lump sum cost to the project.

- Duration of project: 270 days
- Planning cost for field management: $725,334
- Planning cost for final D&D report: $8,920.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.3.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. This activity is considered a lump sum cost to the project. The final site survey by the FH survey team is part of the as-built process and is based on the area of the waste site.

- Duration of project management: 270 days
- Project management cost: $460,575
- Planning cost for final D&D report: $2,019
- Area of final site survey: 1 acre
- Planning cost for final site survey: $408.

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)
  - Area of cap system = 33,303 ft^2 = 1 acre (minimum)
  - Team hours to complete inspections = 0.87 day (1 day for every 50,000 ft^2)
  - Daily inspection rate (2 technicians) = \$896/day (\$56/h/person)
  - Barrier cover inspection of surface soil = \$896 x 0.87 day = \$781/event
  - Radiation surveys of surface soil = \$1,000 for every 5,000 ft^2 = \$8,712/event
- Cap maintenance (footprint of cap system)
  - Area of cap system = 1 acre (minimum)
  - Area requiring repair (10% of total area) = 484 yd^2
  - Volume of cap repair (2 ft) = 324 yd^3
  - Oversight (soil placement 130 yd^3/h) = 0.3 day
  - Oversight (vegetation 5,000 yd^2/h) = 0.1 day.

Oversight will be performed by one FH engineer at \$60/h.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section F3.1.4.

F3.5.4 Representative Waste Site 216-S-7 Crib (Cost Tables F-14 through F-17)

The site work is estimated to take 61 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown. The RTD process and the barrier construction process will both use one crew to perform the work.

- Mobilization: 10 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites
- Excavate contaminated and uncontaminated soil: 21 days
- Site work, includes backfilling excavation: 11 days
- Capping: 7 days

- Revegetation: 2 days
- Demobilize: 10 days.

Total construction duration = 61 days = 12.2 weeks = 2.9 months.

Site Description: The basis for the following information can be found in Table F-2.

- Area of contamination: 50 ft x 100 ft = 5,000 ft^2
- Depth of clean overburden: 15 ft bgs
- Total excavated depth: 27 ft bgs
- Volume of contaminated soil to be removed: 5,651 yd^3
- Total excavated volume (1.5:1 side slopes): 12,715 yd^3
- Volume of clean overburden: 7,064 yd^3
- Volume of borrow from onsite source: 5,651 yd^3
- Area of waste site with 20-ft overlap: (50+(2x20)) x (100+(2x20)) = 0.28 acres
- Type of cap: ET Capillary
- Side slope of cap: 3:1
- Depth of cap: 5.5 ft
- Horizontal side slope distance: 22.8 ft
- Cap footprint length: (50+((20+22.8)x2)) = 135.6 ft
- Cap footprint width: (100+((20+22.8)x2)) = 185.6 ft
- Area of cap footprint: 135.6 x 185.6 = 25,167 ft^2.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories. Some equipment will be equipment mobilized for the excavation, and different equipment will be mobilized for the cap construction.

Typical excavation (RTD) heavy equipment mobilized to and demobilized from the site per crew is as follows:

- Large dozer
- 2- to 3-yd^3 excavator
- 4- to 5-yd^3 wheel loader
- Two off-highway dump trucks
- Backhoe loader
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Three trucks with tilt container beds.

Typical cap construction heavy equipment mobilized to and demobilized from the site per crew is as follows:

- Large dozer
- Two LPG dozers

- 2- to 3-yd^3 excavator
- Two 4- 5-yd^3 wheel loaders
- Soil vib rollers
- Two off-highway dump trucks
- Pug mill with hoppers and belt loaders
- Two farm tractors
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $11,725 to mobilize. The cost to demobilize is planned at $23,988, which also includes the decontamination of the equipment included, along with moving the equipment to the storage yard. This includes the FP labor to clean the equipment. The FH RCT labor hours support to decontamination of the construction equipment is 40 hours, which is planned at $2,462.

Contractor personnel are provided training before the start of work at the site. The cost of training is planned at $55,486. The training will meet site requirements to work at a waste site. The typical crews (one for RTD and one for capping) were used to calculate the cost of training.

The contractor will set up or construct a temporary staging area, two office trailers, change trailer, storage container, truck scales, and survey building at a cost of $42,937. The rental cost of the trailers, scales, and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $8,226. Decontamination areas will be set up as part of the site mobilization at a cost of $53,304. The staging area and roads will be scarified as part of demobilization and the planning cost is $862. The decontamination areas also will be removed at a planning cost of $21,020. The office trailers, truck scales, and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site fence is $3,596 to construct and $794 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $712 and is based on the area of the waste site.

Fluor Hanford Sampling and Crew Support: FH will perform all sampling required.

Soil sampling (noncontaminated soil, ERDF certification, pre-verification, verification samples). See Section F3.3.1 for sampling rate and process.

- Noncontaminated samples (includes QA samples): 7 samples
- ERDF certification samples(includes QA samples): 9 samples
- Pre-verification samples(includes QA samples): 16 samples

- Verification samples (includes QA samples): 8 samples
- Soil-sampling cost: $141,269.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 63 samples
- Quarterly environmental permit samples: 4 samples
- Air-sampling cost: $39,999.

Field sampling FH crew support:

- Sampling crew: 95 hours
- Sampling crew cost: $10,313.

Site Work: This activity covers the backfilling of the site with the overburden soil and soil hauled from an onsite borrow source. This activity has three items of work: loading and hauling the overburden, loading and hauling the borrow soil, and spreading backfill at the site. Dust control is included in this work. See Section F3.3.1 for crews and production rates. For this site, four crews will be used due to the amount of overburden and borrow soil to be hauled and spread. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.

- Load/haul overburden volume: 7,064 yd^3
- Planning cost to load/haul overburden: $17,203
- Load/haul borrow soil volume: 5,651 yd^3
- Planning cost to load/haul borrow soil: $37,825
- Spread backfill/compaction volume: 12,715 yd^3
- Planning cost to spread backfill/compaction: $31,802
- Miscellaneous cleanup duration: 13 weeks
- Planning cost for miscellaneous cleanup: $2,217.

Site revegetation is part of site restoration. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site, overburden stockpile, staging areas, and access roads.

- Total area to be revegetated: 4 acres
- Planning cost for reseeding: $4,611
- Planning cost for planting sagebrush: $5,140
- Planning cost for Irrigation: $24,072.

Soil Excavation:

- Excavation: The work activities covered by Excavation include stripping and stockpiling overburden soil, and excavation of contaminated soil. The contaminated soil will be placed directly into the ERDF containers. The moving of the containers from the excavation site and the processing of the containers are covered in the container loading and handling process description (see below). Dust suppression is included in each

activity. A description of how the work is performed is presented in Section F3.3.1. For this site, four crews will be used due to the amount of overburden and contaminated soil to be removed.

- Overburden soil removed and stockpiled: 7,064 yd^3
- Planning cost to remove overburden: $34,833
- Excavation of contaminated soil: 5,651 yd^3
- Planning cost to excavate contaminated soil: $33,430
- RCT support for soil excavation: 141 hours
- RCT Excavation support cost: $13,020
- FH industrial safety support: 168 hours
- FH industrial safety cost: $11,459.

• Container loading and handling process: This activity involves installing liners in containers, hauling the containers to a survey area, weighing, and unloading at a temporary storage area. See Section F3.3.1 for details of how the work is performed. For this site, four crews will be used due to the amount of contaminated soil to be handled.

  - Number of ERDF containers hauled, weighed, and processed: 505
  - Planning cost for hauling and securing the containers: $45,941
  - Planning cost for preparing containers for loading: $44,846
  - Planning cost for weighing and storing containers: $23,313
  - RCT support for queue operations survey: 85 hours
  - RCT support for queue operations planning cost: $2,616
  - RCT support for container radiation surveying: 255 hours
  - RCT support for container radiation surveying planning cost: $15,698.

• ERDF transportation and disposal: The planning cost for disposal and transportation is $980 per container without overhead charges. This cost includes the disposal fee, the transportation cost from the wastes site staging area to ERDF, and the replacement of the loaded container with an empty container at the staging area.

  - Total number of containers required: 505
  - Cost of containers: $571,351.

Installation of Cap: Site 216-S-7 Crib requires an ET Capillary Barrier. The design, construction, and production rates for the barrier are discussed above in the General Assumptions.

The following areas and volumes will be used for the cost estimates:

- Area (footprint) of cap: 25,167 ft^2
- Pre-level volume: 0 yd^3
- Layer 8 – volume of engineered fill: 1,408 yd^3
- Layer 3 – volume of Sand: 384 yd^3
- Layer 3 – area of geotextile: 2,001 yd^2
- Layer 2 – volume of silt: 1,106 yd^3

- Layer 1 – volume of silt and pea gravel mixture: 939 yd^3
- Side slope – volume gravel filter: 220 yd^3
- Side slope – volume ballast: 220 yd^3
- Side slope – volume fractured basalt and silt: 619 yd^3
- The planning costs for the layers are as follows:
  - Pre-level: $0
  - Layer 8 engineered fill: $14,340
  - Layer 3 sand: $18,793
  - Layer 2 silt: $10,033
  - Layer 1 silt and pea gravel: $7,825
  - Side slope: $46,336
  - Silt pit process operations: $10,214.
- Other items of work that are involved in the construction of the barrier are construction survey/elevation control, soils compaction testing, site cleanup, construction of a site fence, and FH RCT support.
  - Planning cost for surveying: $5,305
  - Planning cost for soils compaction testing: $1,098
  - RCT support for construction cost: $1,052.

Construction Staff: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. This activity is considered a lump sum cost to the project.

- Duration of project: 61 days
- Planning cost for field management: $163,871
- Planning cost for final D&D report: $8,920.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.3.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. This activity is considered a lump sum cost to the project. The final site survey by the FH survey team is part of the as-built process and is based on the area of the waste site.

- Duration of project management: 61 days
- Project management cost: $104,055
- Planning cost for final D&D report: $2,019
- Area of final site survey: 1 acre
- Planning cost for final site survey: $408.

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities

performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)

  - Area of cap system = 25,167 ft^2 = 1 acre (minimum)
  - Team hours to complete inspections = 0.87 day (1 day for every 50,000 ft^2)
  - Daily inspection rate (2 technicians) = \$896/day (\$56/h/person)
  - Barrier cover inspection of surface soil = \$896 x 0.87 day = \$781/event
  - Radiation surveys of surface soil = \$1,000 for every 5,000 ft^2 = \$8,712/event

- Cap maintenance (footprint of cap system)

  - Area of cap system = 1 acre (minimum)
  - Area requiring repair (10% of total area) = 484 yd^2
  - Volume of cap repair (2 ft) = 324 yd^3
  - Oversight (soil placement 130 yd^3/h) = 0.3 day
  - Oversight (vegetation 5,000 yd^2/h) = 0.1 day.

Oversight will be performed by one FH engineer at \$60/h.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section F3.1.4.

F3.5.5 Representative Waste Site 216-A-10 Crib (Cost Tables F-14 through F-17)

The site work is estimated to take 218 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown. The RTD process and the barrier construction process will both use one crew to perform the work.

- Mobilization: 10 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites

- Excavate contaminated and uncontaminated soil: 119 days

- Site work, includes backfilling excavation: 65 days

- Capping: 12 days

- Revegetation: 2 days
- Demobilize: 10 days.

Total construction duration = 218 days = 43.6 weeks = 10.4 months.

Site Description: The basis for the following information can be found in Table F-2.

- Area of contamination: 275 ft x 45 ft = 12,375 ft^2
- Depth of clean overburden: 30 ft bgs
- Total excavated depth: 50 ft bgs
- Volume of contaminated soil to be removed: 54,444 yd^3
- Total excavated volume (1.5:1 side slopes): 77,778 yd^3
- Volume of clean overburden: 23,333 yd^3
- Volume of borrow from onsite source: 54,444 yd^3
- Area of waste site with 20-ft overlap: (275+(2x20)) x (45+(2x20)) = 0.61 acre
- Type of cap: ET Capillary
- Side slope of cap: 3:1
- Depth of cap: 5.5 ft
- Horizontal side slope distance: 22.8 ft
- Cap footprint length: (275+((20+22.8)x2)) = 360.6 ft
- Cap footprint width: (45+((20+22.8)x2)) = 130.6 ft
- Area of cap footprint: 360.6 x 130.6 = 47,094 ft^2.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories. There will be equipment mobilized for the excavation and different equipment mobilized for the cap construction.

Typical excavation (RTD) heavy equipment mobilized to and demobilized from the site per crew is as follows:

- Large dozer
- 2- to 3-yd^3 excavator
- 4- to 5-yd^3 wheel loader
- Two off-highway dump trucks
- Backhoe loader
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Three trucks with tilt container beds.

Typical cap construction heavy equipment mobilized to and demobilized from the site per crew is as follows:

- Large dozer
- Two LPG dozers

- 2- to 3-yd^3 excavator
- Two 4- to 5-yd^3 wheel loaders
- Soil vib rollers
- Two off-highway dump trucks
- Pug mill with hoppers and belt loaders
- Two farm tractors
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $11,725 to mobilize. The cost to demobilize is planned at $23,988, which also includes the decontamination of the equipment included, along with moving the equipment to the storage yard. This includes the FP labor to clean the equipment. The FH RCT labor hours support to decontamination of the construction equipment is 40 hours, which is planned at $2,462.

Contractor personnel are provided training before the start of work at the site. The cost of training is planned at $55,486. The training will meet site requirements to work at a waste site. The typical crews (one for RTD and one for capping) were used to calculate the cost of training.

The contractor will set up or construct a temporary staging area, two office trailers, change trailer, storage container, truck scales, and survey building at a cost of $82,457. The rental cost of the trailers, scales, and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $8,226. Decontamination areas will be set up as part of the site mobilization at a cost of $53,304. The staging area and roads will be scarified as part of demobilization and the planning cost is $862. The decontamination areas also will be removed at a planning cost of $21,020. The office trailers, truck scales, and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site fence is $5,655 to construct and $1,120 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $3,461 and is based on the area of the waste site.

Fluor Hanford Sampling and Crew Support: FH will perform all sampling required.

Soil sampling (noncontaminated soil, ERDF certification, pre-verification, verification samples). See Section F3.3.1 for sampling rate and process.

- Noncontaminated samples (includes QA samples): 7 samples
- ERDF certification samples (includes QA samples): 42 samples
- Pre-verification samples (includes QA samples): 16 samples

- Verification samples (includes QA samples): 18 samples
- Soil-sampling cost: $158,394.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 370 samples
- Quarterly environmental permit samples: 10 samples
- Air-sampling cost: $226,864.

Field sampling FH crew support:

- Sampling crew: 444 hours
- Sampling crew cost: $50,696.

Site Work: This activity covers the backfilling of the site with the overburden soil and soil hauled from an onsite borrow source. This activity has three items of work: loading and hauling the overburden, loading and hauling the borrow soil, and spreading backfill at the site. Dust control is included in this work. See Section F3.3.1 for crews and production rates. For this site, four crews will be used due to the amount of overburden and borrow soil to be hauled and spread. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.

- Load/haul overburden volume: 23,333 yd^3
- Planning cost to load/haul overburden: $113,651
- Load/haul borrow soil volume: 54,444 yd^3
- Planning cost to load/haul borrow soil: $208,235
- Spread backfill/compaction volume: 77,778 yd^3
- Planning cost to spread backfill/compaction: $194,529
- Miscellaneous cleanup duration: 50 weeks
- Planning cost for miscellaneous cleanup: $3,389.

Site revegetation is part of site restoration. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site, overburden stockpile, staging areas, and access roads.

- Total area to be revegetated: 4 acres
- Planning cost for reseeding: $4,611
- Planning cost for planting sagebrush: $5,140
- Planning cost for Irrigation: $24,072.

Soil Excavation:

- Excavation: The work activities covered by Excavation include stripping and stockpiling overburden soil, and excavation of contaminated soil. The contaminated soil will be placed directly into the ERDF containers. The moving of the containers from the excavation site and the processing of the containers are covered in the container loading and handling process description (see below). Dust suppression is included in each

activity. A description of how the work is performed is presented in Section F3.3.1. For this site, four crews will be used due to the amount of overburden and contaminated soil to be removed.

- Overburden soil removed and stockpiled: 23,333 yd^3
- Planning cost to remove overburden: $228,224
- Excavation of contaminated soil: 54,444 yd^3
- Planning cost to excavate contaminated soil: $184,040
- RCT support for soil excavation: 832 hours
- RCT Excavation support cost: $76,828
- FH industrial safety support: 952 hours
- FH industrial safety cost: $64,938.

- Container loading and handling process: This activity involves installing liners in containers, hauling the containers to a survey area, weighing, and unloading at a temporary storage area. See Section F3.3.1 for details of how the work is performed. For this site, four crews will be used due to the amount of contaminated soil to be handled.

  - Number of ERDF containers hauled, weighed, and processed: 2,780
  - Planning cost for hauling and securing the containers: $252,910
  - Planning cost for preparing containers for loading: $246,876
  - Planning cost for weighing and storing containers: $128,341
  - RCT support for queue operations survey: 464 hours
  - RCT support for queue operations planning cost: $14,282
  - RCT support for container radiation surveying: 1,392 hours
  - RCT support for container radiation surveying planning cost: $85,693.

- ERDF transportation and disposal: The planning cost for disposal and transportation is $980 per container without overhead charges. This cost includes the disposal fee, the transportation cost from the wastes site staging area to ERDF, and the replacement of the loaded container with an empty container at the staging area.

  - Total number of containers required: 2,780
  - Cost of containers: $3,131,040.

Installation of Cap: Site 216-A-10 Crib requires an ET Capillary Barrier. The design, construction, and production rates for the barrier are discussed above in the General Assumptions.

The following areas and volumes will be used for the cost estimates:

- Area (footprint) of cap: 47,094 ft^2
- Pre-level volume: 0 yd^3
- Layer 8 – volume of engineered fill: 2,752 yd^3
- Layer 3 – volume of sand: 764 yd^3
- Layer 3 – area of geotextile: 3,982 yd^2
- Layer 2 – volume of silt: 2,241 yd^3

- Layer 1 – volume of silt and pea gravel mixture: 1,956 yd^3
- Side slope – volume gravel filter: 346 yd^3
- Side slope – volume ballast: 346 yd^3
- Side slope – volume fractured basalt and silt: 970 yd^3
- The planning costs for the layers are as follows:

  - Pre-level: $0
  - Layer 8 engineered fill: $28,028
  - Layer 3 sand: $37,393
  - Layer 2 silt: $18,736
  - Layer 1 silt and pea gravel: $16,354
  - Side slope: $72,695
  - Silt pit process operations: $21,341.

- Other items of work that are involved in the construction of the barrier are construction survey/elevation control, soils compaction testing, site cleanup, construction of a site fence, and FH RCT support.

  - Planning cost for surveying: $14,442
  - Planning cost for soils compaction testing: $4,282
  - RCT support for construction cost: $1,973.

Construction Staff: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. This activity is considered a lump sum cost to the project.

- Duration of project: 218 days
- Planning cost for field management: $585,640
- Planning cost for final D&D report: $8,920.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.3.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. This activity is considered a lump sum cost to the project. The final site survey by the FH survey team is part of the as-built process and is based on the area of the waste site.

- Duration of project management: 218 days
- Project management cost: $371,872
- Planning cost for final D&D report: $2,019
- Area of final site survey: 1 acre
- Planning cost for final site survey: $408.

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities

performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)

  - Area of cap system = 47,094 ft^2 = 1 acre (approximate)
  - Team hours to complete inspections = 0.87 day (1 day for every 50,000 ft^2)
  - Daily inspection rate (2 technicians) = \$896/day (\$56/h/person)
  - Barrier cover inspection of surface soil = \$896 x 0.87 day = \$781/event
  - Radiation surveys of surface soil = \$1,000 for every 5,000 ft^2 = \$8,712/event.

- Cap maintenance (footprint of cap system)

  - Area of cap system = 1 acre (approximate)
  - Area requiring repair (10% of total area) = 484 yd^2
  - Volume of cap repair (2 ft) = 324 yd^3
  - Oversight (soil placement 130 yd^3/h) = 0.3 day
  - Oversight (vegetation 5,000 yd^2/h) = 0.1 day.

Oversight will be performed by one FH engineer at \$60/h.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section F3.1.4.

F3.5.6 Representative Waste Site 216-A-36B Crib (Cost Tables F-14 through F-17)

The site work is estimated to take 151 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown. The RTD process and the barrier construction process will both use one crew to perform the work.

- Mobilization: 10 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites

- Excavate contaminated and uncontaminated soil: 50 days

- Excavate/remove TRU waste: 34 days

- Site work, includes backfilling excavation: 30 days

- Capping: 15 days

- Revegetation: 2 days
- Demobilize: 10 days.

Total construction duration = 151 days = 30.2 weeks = 7.2 months.

Site Description: The basis for the following information can be found in Table F-2.

- Area of contamination: 500 ft x 10 ft = 5,000 ft^2
- Depth of clean overburden: 15 ft bgs
- Total excavated depth: 30 ft bgs
- Volume of contaminated soil to be removed: 8,431 yd^3
- Volume of TRU contaminated soil to be removed: 612 yd^3
- Total excavated volume (1.5:1 side slopes): 33,911 yd^3
- Volume of clean overburden: 24,868 yd^3
- Volume of borrow from onsite source: 2,262 yd^3
- Area of waste site with 20-ft overlap: (500+(2x20)) x (10+(2x20)) = 0.62 acre
- Type of cap: ET Capillary
- Side slope of cap: 3:1
- Depth of cap: 5.5 ft
- Horizontal side slope distance: 22.8 ft
- Cap footprint length: (500+((20+22.8)x2)) = 585.6 ft
- Cap footprint width: (10+((20+22.8)x2)) = 95.6 ft
- Area of cap footprint: 585.6 x 95.6 = 55,983 ft^2.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories. There will be equipment mobilized for the excavation and different equipment mobilized for the cap construction.

Typical excavation (RTD) heavy equipment mobilized to and demobilized from the site per crew is as follows:

- Large dozer
- 2- to 3-yd^3 excavator
- 1-yd^3 excavator
- 10-ton crane
- 2- to 3-yd^3 loader
- 4- to 5-yd^3 wheel loader
- Two off-highway dump trucks
- Backhoe loader
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Three trucks with tilt container beds.

Typical cap construction heavy equipment mobilized to and demobilized from the site per crew is as follows:

- Large dozer
- Two LPG dozers
- 2- to 3-yd^3 excavator
- Two 4- to 5-yd^3 wheel loaders
- Soil vib rollers
- Two off-highway dump trucks
- Pug mill with hoppers and belt loaders
- Two farm tractors
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $11,725 to mobilize. The cost to demobilize is planned at $23,988, which also includes the decontamination of the equipment included, along with moving the equipment to the storage yard. This includes the FP labor to clean the equipment. The FH RCT labor hours support to decontamination of the construction equipment is 40 hours, which is planned at $2,462.

Contractor personnel are provided training before the start of work at the site. The cost of training is planned at $83,229. The training will meet site requirements to work at a waste site. The typical crews (one for RTD and one for capping) were used to calculate the cost of training.

The contractor will set up or construct a temporary staging area, two office trailers, change trailer, storage container, truck scales, and survey building at a cost of $67,637. The rental cost of the trailers, scales, and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $8,226. Decontamination areas will be set up as part of the site mobilization at a cost of $162,605. The staging area and roads will be scarified as part of demobilization and the planning cost is $862. The decontamination areas also will be removed at a planning cost of $21,020. The office trailers, truck scales, and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site fence is $6,145 to construct and $1,205 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $3,461 and is based on the area of the waste site.

Fluor Hanford Sampling and Crew Support: FH will perform all sampling required.

Soil sampling (noncontaminated soil, ERDF certification, pre-verification, verification samples). See Section F3.3.1 for sampling rate and process.

- Noncontaminated samples (includes QA samples): 7 samples
- ERDF certification samples (includes QA samples): 12 samples
- Pre-verification samples (includes QA samples): 16 samples
- Verification samples (includes QA samples): 13 samples
- TRU samples (includes QA samples): 408 samples
- Soil-sampling cost: $1,601,567.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 216 samples
- Quarterly environmental permit samples: 6 samples
- Air-sampling cost: $132,536.

Field sampling FH crew support:

- Sampling crew: 1,461 hours
- Sampling crew cost: $74,741.

Site Work: This activity covers the backfilling of the site with the overburden soil and soil hauled from an onsite borrow source. This activity has three items of work: loading and hauling the overburden, loading and hauling the borrow soil, and spreading backfill at the site. Dust control is included in this work. See Section F3.3.1 for crews and production rates. For this site, four crews will be used due to the amount of overburden and borrow soil to be hauled and spread. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.

- Load/haul overburden volume: 24,868 yd^3
- Planning cost to load/haul overburden: $60,991
- Load/haul borrow soil volume: 9,043 yd^3
- Planning cost to load/haul borrow soil: $56,432
- Spread backfill/compaction volume: 33,911 yd^3
- Planning cost to spread backfill/compaction: $83,724
- Miscellaneous cleanup duration: 24 weeks
- Planning cost for miscellaneous cleanup: $4,707.

Site revegetation is part of site restoration. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site, overburden stockpile, staging areas, and access roads.

- Total area to be revegetated: 5 acres
- Planning cost for reseeding: $5,764
- Planning cost for planting sagebrush: $6,425
- Planning cost for irrigation: $30,090.

Soil Excavation:

- Excavation: The work activities covered by Excavation include stripping and stockpiling overburden soil, and excavation of contaminated soil. The contaminated soil will be placed directly into the ERDF containers. The moving of the containers from the excavation site and the processing of the containers are covered in the container loading and handling process description (see below). Dust suppression is included in each activity. A description of how the work is performed is presented in Section F3.3.1. For this site, four crews will be used due to the amount of overburden and contaminated soil to be removed.

  - Overburden soil removed and stockpiled: 24,868 yd^3
  - Planning cost to remove overburden: $123,489
  - Excavation of contaminated soil: 8,431 yd^3
  - Excavation of TRU contaminated soil: 612 yd^3
  - Planning cost to excavate contaminated soil (including TRU): $3,128,567
  - RCT support for soil excavation: 324 hours
  - RCT excavation support cost: $69,860
  - FH industrial safety support: 376 hours
  - FH industrial safety cost: $25,647.

- Container loading and handling process: This activity involves installing liners in containers, hauling the containers to a survey area, weighing, and unloading at a temporary storage area. See Section F3.3.1 for details of how the work is performed. For this site, four crews will be used due to the amount of contaminated soil to be handled.

  - Number of ERDF containers hauled, weighed, and processed: 754
  - Number of TRU containers hauled, weighed, and processed: 408
  - Planning cost for hauling and securing the containers: $161,158
  - Planning cost for preparing containers for loading: $66,958
  - Planning cost for weighing and storing containers: $71,716
  - RCT support for queue operations survey: 126 hours
  - RCT support for queue operations planning cost: $3,878
  - RCT support for container radiation surveying: 378 hours
  - RCT support for container radiation surveying planning cost: $23,270.

- ERDF transportation and disposal: The planning cost for disposal and transportation is $980 per container without overhead charges. This cost includes the disposal fee, the transportation cost from the wastes site staging area to ERDF, and the replacement of the loaded container with an empty container at the staging area.

  - Total number of containers required: 754
  - Cost of containers: $851,511.

- TRU transportation and storage: The planning cost for moving TRU containers to CWC for inspection, test, and temporary storage; waste profile study; sampling at INEEL; and transport to WIPP.
  - Total number of SWB containers required: 408
  - Planning cost: $4,885,736.

Installation of Cap: Site 216-A-19 Trench requires an ET Capillary Barrier. The design, construction, and production rates for the barrier are discussed above in the General Assumptions.

The following areas and volumes will be used for the cost estimates:

- Area (footprint) of cap: 56,296 ft^2
- Pre-level volume: 0 yd^3
- Layer 8 – volume of engineered fill: 3,186 yd^3
- Layer 3 – volume of sand: 867 yd^3
- Layer 3 – area of geotextile: 4,523 yd^2
- Layer 2 – volume of silt: 2,488 yd^3
- Layer 1 – volume of silt and pea gravel mixture: 2,073 yd^3
- Side slope – volume gravel filter: 487 yd^3
- Side slope – volume ballast: 487 yd^3
- Side slope – volume fractured basalt and silt: 1,364 yd^3
- The planning costs for the layers are as follows:
  - Pre-level: $0
  - Layer 8 engineered fill: $32,448
  - Layer 3 sand: $42,452
  - Layer 2 silt: $24,472
  - Layer 1 silt and pea gravel: $20,216
  - Side slope: $102,241
  - Silt pit process operations: $22,621
- Other items of work that are involved in the construction of the barrier are construction survey/elevation control, soils compaction testing, site cleanup, construction of a site fence, and FH RCT support.
  - Planning cost for surveying: $15,621
  - Planning cost for soils compaction testing: $4,721
  - RCT support for construction cost: $2,368.

Construction Staff: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. This activity is considered a lump sum cost to the project.

- Duration of project: 151 days
- Planning cost for field management: $4052,650
- Planning cost for final D&D report: $8,920.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.3.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. This activity is considered a lump sum cost to the project. The final site survey by the FH survey team is part of the as-built process and is based on the area of the waste site.

- Duration of project management: 151 days
- Project management cost: $257,581
- Planning cost for final D&D report: $2,019
- Area of final site survey: 4 acres
- Planning cost for final site survey: $2,043.

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)
  - Area of cap system = 56,296 ft^2
  - Team hours to complete inspections = 1.1 days (1 day for every 50,000 ft^2)
  - Daily inspection rate (2 technicians) = $896/day ($56/h/person)
  - Barrier cover inspection of surface soil = $896 x 1.1 days = $986/event
  - Radiation surveys of surface soil = $1,000 for every 5,000 ft^2 = $11,259/event
- Cap maintenance (footprint of cap system)
  - Area of cap system = 1.1 acre
  - Area requiring repair (10% of total area) = 625 yd^2
  - Volume of cap repair (2 ft) = 419 yd^3
  - Oversight (soil placement 130 yd^3/h) = 0.4 day
  - Oversight (vegetation 5,000 yd^2/h) = 1.4 days.

Oversight will be performed by one FH engineer at $60/h.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section F3.1.4.

F3.5.7 Representative Waste Site 216-A-37-1 Crib (Cost Tables F-14 through F-17)

The site work is estimated to take 79 working days based on the following breakdown. Time required for remedial engineering, proposal/bidding/selection process, and startup submittals/permits is in addition to the times shown. The RTD process and the barrier construction process will both use one crew to perform the work.

- Mobilization: 10 days to mobilize personnel, equipment, and materials; construct staging areas with roads; install temporary trailers with utilities; and set up survey buildings and decontamination sites
- Excavate contaminated and uncontaminated soil: 26 days
- Site work, includes backfilling excavation: 13 days
- Capping: 18 days
- Revegetation: 2 days
- Demobilize: 10 days.

Total construction duration = 79 days = 15.8 weeks = 3.8 months.

Site Description: The basis for the following information can be found in Table F-2.

- Area of contamination: 700 ft x 10 ft = 7,000 ft^2
- Depth of clean overburden: 6 ft bgs
- Total excavated depth: 16 ft bgs
- Volume of contaminated soil to be removed: 9,117 yd^3
- Total excavated volume (1.5:1 side slopes): 14,587 yd^3
- Volume of clean overburden: 5,470 yd^3
- Volume of borrow from onsite source: 9,117 yd^3
- Area of waste site with 20-ft overlap: (700+(2x20)) x (10+(2x20)) = 0.85 acre
- Type of cap: ET Capillary
- Side slope of cap: 3:1
- Depth of cap: 5.5 ft
- Horizontal side slope distance: 22.8 ft
- Cap footprint length: (700+((20+22.8)x2)) = 785.6 ft
- Cap footprint width: (10+((20+22.8)x2)) = 95.6 ft
- Area of cap footprint: 785.6 x 95.6 = 75,103 ft^2.

Mobilization and Demobilization: The activities involved in mobilizing and demobilizing personnel, equipment, and other startup work have been divided into several categories. There will be equipment mobilized for the excavation and different equipment mobilized for the cap construction.

Typical excavation (RTD) heavy equipment mobilized to and demobilized from the site per crew is as follows:

- Large dozer
- 2- to 3-yd^3 excavator
- 4- to 5-yd^3 wheel loader
- Two off-highway dump trucks
- Backhoe loader
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Three trucks with tilt container beds.

Typical cap construction heavy equipment mobilized to and demobilized from the site per crew is as follows:

- Large dozer
- Two LPG dozers
- 2- to 3-yd^3 excavator
- Two 4- to 5-yd^3 wheel loaders
- Soil vib rollers
- Two off-highway dump trucks
- Pug mill with hoppers and belt loaders
- Two farm tractors
- Motor grader
- Six semi-tractors and 20-yd^3 bottom dump trailers
- Two 4,000- to 6,000-gal water trucks
- Flatbed truck
- Revegetation equipment: seed drill, mulcher, and tiller.

The cost of moving equipment 35 miles from a commercial storage yard to the waste site is planned at $11,725 to mobilize. The cost to demobilize is planned at $23,988, which also includes the decontamination of the equipment included, along with moving the equipment to the storage yard. This includes the FP labor to clean the equipment. The FH RCT labor hours support to decontamination of the construction equipment is 40 hours, which is planned at $2,462.

Contractor personnel are provided training before the start of work at the site. The cost of training is planned at $55,486. The training will meet site requirements to work at a waste site. The typical crews (one for RTD and one for capping) were used to calculate the cost of training.

The contractor will set up or construct a temporary staging area, two office trailers, change trailer, storage container, truck scales, and survey building at a cost of $47,877. The rental cost of the trailers, scales, and utilities also is included and is based on the duration of the work. Site access roads also will be constructed at a cost of $8,226. Decontamination areas will be set up as part of the site mobilization at a cost of $53,304. The staging area and roads will be scarified as part of demobilization and the planning cost is $862. The decontamination areas also will be removed at a planning cost of $21,020. The office trailers, truck scales, and storage containers will be removed by a contractor or offsite vender and are considered part of the rental cost.

A temporary fence, constructed of steel post with orange mesh fabric, will be placed around the waste site work area. The planning cost for this site fence is $7,459 to construct and $1,477 to remove.

Before remediation work starts at the waste site, a boundary/topog/location survey will be performed by the contractor. The planning cost for this work is $2,596 and is based on the area of the waste site.

Fluor Hanford Sampling and Crew Support: FH will perform all sampling required.

Soil sampling (noncontaminated soil, ERDF certification, pre-verification, verification samples). See Section F3.3.1 for sampling rate and process.

- Noncontaminated samples (includes QA samples): 7 samples
- ERDF certification samples (includes QA samples): 13 samples
- Pre-verification samples (includes QA samples): 16 samples
- Verification samples (includes QA samples): 10 samples
- Soil-sampling cost: $164,731.

Air sampling (industrial and environmental). See assumption for sampling rate.

- Industrial air samples: 81 samples
- Quarterly environmental permit samples: 4 samples
- Air-sampling cost: $50,746.

Field sampling FH crew support:

- Sampling crew: 115 hours
- Sampling crew cost: $12,688.

Site Work: This activity covers the backfilling of the site with the overburden soil and soil hauled from an onsite borrow source. This activity has three items of work: loading and hauling the overburden, loading and hauling the borrow soil, and spreading backfill at the site. Dust control is included in this work. See Section F3.3.1 for crews and production rates. For this site, four crews will be used due to the amount of overburden and borrow soil to be hauled and spread. Miscellaneous site cleanup includes the labor and equipment to cover work area cleanup on a weekly basis.

- Load/haul overburden volume: 5,470 yd^3
- Planning cost to load/haul overburden: $13,322
- Load/haul borrow soil volume: 9,117 yd^3
- Planning cost to load/haul borrow soil: $61,024
- Spread backfill/compaction volume: 14,587 yd^3
- Planning cost to spread backfill/compaction: $36,484
- Miscellaneous cleanup duration: 16 weeks
- Planning cost for miscellaneous cleanup: $6,079.

Site revegetation is part of site restoration. This work covers the seeding of native dry land grasses, planting sagebrush, and irrigation for four times during the spring and early summer months. The areas to be revegetated include the waste site, overburden stockpile, staging areas, and access roads.

- Total area to be revegetated: 6 acres
- Planning cost for reseeding: $6,917
- Planning cost for planting sagebrush: $7,710
- Planning cost for irrigation: $36,109.

Soil Excavation:

- Excavation: The work activities covered by Excavation include stripping and stockpiling overburden soil, and excavation of contaminated soil. The contaminated soil will be placed directly into the ERDF containers. The moving of the containers from the excavation site and the processing of the containers are covered in the container loading and handling process description (see below). Dust suppression is included in each activity. A description of how the work is performed is presented in Section F3.3.1. For this site, four crews will be used due to the amount of overburden and contaminated soil to be removed.

  - Overburden soil removed and stockpiled: 5,470 yd^3
  - Planning cost to remove overburden: $26,973
  - Excavation of contaminated soil: 9,117 yd^3
  - Planning cost to excavate contaminated soil: $46,305
  - RCT support for soil excavation: 180 hours
  - RCT excavation support cost: $16,621
  - FH industrial safety support: 208 hours
  - FH industrial safety cost: $14,188.

- Container loading and handling process: This activity involves installing liners in containers, hauling the containers to a survey area, weighing, and unloading at a temporary storage area. See Section F3.3.1 for details of how the work is performed. For this site, four crews will be used due to the amount of contaminated soil to be handled.
  - Number of ERDF containers hauled, weighed, and processed: 815
  - Planning cost for hauling and securing the containers: $74,125
  - Planning cost for preparing containers for loading: $72,375
  - Planning cost for weighing and storing containers: $37,625
  - RCT support for queue operations survey: 68 hours
  - RCT support for queue operations planning cost: $4,186
  - RCT support for container radiation surveying: 408 hours.
  - RCT support for container radiation surveying planning cost: $25,116.
- ERDF transportation and disposal: The planning cost for disposal and transportation is $980 per container without overhead charges. This cost includes the disposal fee, the transportation cost from the wastes site staging area to ERDF, and the replacement of the loaded container with an empty container at the staging area.
  - Total number of containers required: 815
  - Cost of containers: $920,144.

Installation of Cap: Site 216-A-37-1 Crib requires an ET Capillary Barrier. The design, construction, and production rates for the barrier are discussed above in the General Assumptions.

The following areas and volumes will be used for the cost estimates:

- Area (footprint) of cap: 75,103 ft^2
- Pre-level volume: 0 yd^3
- Layer 8 – volume of engineered fill: 4,253 yd^3
- Layer 3 – volume of sand: 1,160 yd^3
- Layer 3 – area of geotextile: 6,050 yd^2
- Layer 2 – volume of silt: 3,333 yd^3
- Layer 1 – volume of silt and pea gravel mixture: 2,783 yd^3
- Side slope – volume gravel filter: 635 yd^3
- Side slope – volume ballast: 635 yd^3
- Side slope – volume fractured basalt and silt: 1,774 yd^3
- The planning costs for the layers are as follows:
  - Pre-level: $0
  - Layer 8 engineered fill: $43,315
  - Layer 3 sand: $56,789
  - Layer 2 silt: $32,848
  - Layer 1 silt and pea gravel: $27,201

  - Side slope: $133,084
  - Silt pit process operations: $30,366.

- Other items of work that are involved in the construction of the barrier are construction survey/elevation control, soils compaction testing, site cleanup, construction of a site fence, and FH RCT support.

  - Planning cost for surveying: $17,390
  - Planning cost for soils compaction testing: $6,258
  - RCT support for construction cost: $3,025.

Construction Staff: The contactor will have a field staff to manage the work at the site. See Section F3.3.1 for a description of the crew and trucks. The duration of this work is based on total project duration. Prepare Final D&D Report includes the cost of the contractor to turn over submittals required to close out the work. This activity is considered a lump sum cost to the project.

- Duration of project: 79 days
- Planning cost for field management: $212,227
- Planning cost for final D&D report: $8,920.

Fluor Hanford Project Management: FH will provide oversight for the duration of the construction activities (mobilization through demobilization). See Section F3.3.1 for a description of the crew. Prepare Final D&D Report includes the cost of the as-built documentation process for FH. This activity is considered a lump sum cost to the project. The final site survey by the FH survey team is part of the as-built process and is based on the area of the waste site.

- Duration of project management: 79 days
- Project management cost: $134,761
- Planning cost for final D&D report: $2,019
- Area of final site survey: 1 acre
- Planning cost for final site survey: $1,634.

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)

  - Area of cap system = 75,103 ft^2 = 1.72 acres
  - Team hours to complete inspections = 1.5 days (1 day for every 50,000 ft^2)
  - Daily inspection rate (2 technicians) = $896/day ($56/h/person)

- Barrier cover inspection of surface soil = \$896 x 1.5 days = \$1,344/event
- Radiation surveys of surface soil = \$1,000 for every 5,000 ft^2 = \$14,985/event

* Cap maintenance (footprint of cap system)

  - Area of cap system = 1.72 acres
  - Area requiring repair (10% of total area) = 832 yd^2
  - Volume of cap repair (2 ft) = 558 yd^3
  - Oversight (soil placement 130 yd^3/h) = 0.5 day
  - Oversight (vegetation 5,000 yd^2/h) = 0.2 day.

Oversight will be performed by one FH engineer at \$60/h.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section F3.1.4.

F3.6 COST REPORTING

F3.6.1 Summary of Cost

A summary of the present-worth costs for each of the representative sites and evaluated Alternatives 2, 4, and 5, presented in Tables F-7, F-13, and F-17, is presented in Chapter 8.0 of this FS.